5-6115-574-14

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT
AND GENERAL SUPPORT MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE

100 KW, 0.8 PF, AC, 120/208-204/416V
3 PHASE, 60 HERTZ, CONVERTIBLE TO
75 KW, 0.8 PF, AC, 110/190-220/380V
50 HERTZ, SKID MOUNTED
(FERMONT MODEL MB-16) FSN 6115-081-2030

HEADQUARTERS, DEPARTMENT OF THE ARMY
JUNE 1972

D 101.11:
READEX FICHE best copy available
Reproduced from poor document.

WARNING

Take particular heed to specific warnings throughout this manual.

High voltage is used in the operation of this equipment.

Death or injury or severe burns may result if personnel fail to observe safety precautions.

Do not operate the generator set until the ground terminal stud has been connected to a suitable ground.

Disconnect the battery ground cable before removing and installing components on engine or in electrical control panel system.

Before making kilowatt load connections for parallel operation, be sure the generator sets are not operating and main circuit breakers are in the OFF position.

Before servicing any part of the generator set, make sure the unit is completely deenergized.

Dangerous gases are generated as a result of operating this equipment.

Utilize extreme caution, do not smoke, or use open flame in the vicinity when servicing batteries. Batteries generate explosive gas during charging.

Do not operate generator sets in inclosed areas unless exhaust gases are properly vented to the outside. Exhaust discharge contains noxious and deadly fumes.

Liquids under pressure are generated as a result of operation of this equipment. Injury or severe burns may result if personnel fail to observe safety precautions.

Never remove the radiator cap unless the engine has stopped and cooled to reduce pressure.

Keep hands and other exposed areas of the body away from any malfunction of high pressure fuel lines.

CAUTION

Damage to the equipment may result if personnel fail to observe cautions.

When removing one of two generator sets operating in parallel, be certain the load on the service lines is not greater than the rating of the remaining unit.

If the generator set is shut down by the operation of a safety device, do not attempt to operate the unit until the cause has been determined and eliminated.

Do not add coolant to the radiator until the engine has cooled.

NOTE

The format of this manual is not in accordance with established Department of the Army specifications because of the short leadtime involved. The technical content has been furnished by the equipment manufacturer and augmented with a Maintenance Allocation Chart (MAC), Items Troop Installed or Authorized List; etc., to insure that it provides the essential data needed to operate and maintain the equipment.

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. *14 February 1975*

Operator's Organizational, Direct Support and General Support Maintenance Manual GENERATOR SET, DIESEL ENGINE, 100 KW, 0.8 PF, AC, 120/208 - 204/416V 3 PHASE, 60 HERTZ, CONVERTIBLE TO 75 KW, 0.8 PF, AC, 110/190 - 220/380V, 50 HERTZ, SKID MOUNTED (FERMONT MODEL MB-16) NSN 6115-00-081-2030

TM 5-6115-574-14, 20 June 1972, is changed as follows:

The title is changed as shown above.

Page 2 of cover. Add the following warnings.

WARNING

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

Dry cleaning solvent, PD 680, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. (38 C.) 138 F. (59 C.).

Page 1-1. Paragraph 1-1.2 is superseded as follows:

1-2.2. You can improve this manual by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and mailing the form to Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished direct to you.

WARNING

Do not rely on grounding or safety devices to prevent accidents. Electrical circuits and equipment are potentially hazardous. Personnel should always exercise caution to prevent injury or possible death due to electrical shock.

Page 3-3. Paragraph 3-3*m* is superseded as follows:

m. Grounding Procedure. Generator sets shall be grounded in order to prevent shock due to defective insulation, or external electrical faults. Poor grounding can endanger personnel, may damage equipment, and can create interference in communication or electronic circuits.

(1) Install one of the following items as a grounding device.

(a) Drive a ground rod, to a depth of at least 8 feet. This is the preferred device, which is available in the Army Supply System.

(b) Drive a ground pipe, 3/4 inch copper or steel, to a depth of at least 8 feet. An existing underground pipe may be used in an emergency.

(c) Bury a 1/4 inch thick iron or steel plate, approximately 18 x 18 inches, with ground cable attached, to a depth of at least 4 feet.

(d) Bury a 1/16 inch thick aluminum or copper plate approximately 18 x 18 inches, with ground cable attached, to a depth of at least 4 feet.

(e) Position a 1/4 inch thick iron or steel plate, or 1/16 inch thick aluminum or copper plate, approximately 18 x 18 inches, on the hard ground or bedrock beneath the trailer stand or roll the wheel of a trailer or track until it comes to rest on top of the grounding plate.

(f) Saturate the area around the grounding device with water to increase conductivity.

(2) Ground cables should be copper. Braided cable is the best, but no. 6, AWG gauge (or larger), copper wire will suffice.

(3) Connect the ground cable from the grounding device to the generator set frame ground post (13, fig. 1), and tighten the nut securely.

Page A-1. Appendix A, References is superseded as follows:

APPENDIX A
REFERENCES

A-1. Fire Protection and Safety

TB 5-4200-200-10 ..... Hand Portable Fire Extinguishers Approved for Army Users
TB MED 251 ..... Noise and Conservation of Hearing

A-2. Lubrication

C9100IL ..... Fuels, Lubricants, Oils and Waxes
LO 5-6115-574-12 ..... Generator Set, Diesel Engine Driven; 100 DKW, 0.8 PF, AC, 120/208V-240/416V,3 Phase, 60 Herta, Convertible to 75 KW, 0.8 PF, AC, 110/190V-220/380V, 50 Hertz, Skid Mounted (Fermont Model MB-16) W/engine Cummins model MH-220-BIG NSN 6115-00-081-2030
TB 703-1 ..... Specification List of Standard Liquid Fuels, Lubricants, Preservatives, and Related Products Authorized for use by the US Army
TB 55-6650-300-15 ..... Spectrometic Oil Analysis

A-3. Painting

AR 746-1 ..... Color, Marking, and Preparation of Equipment for Shipment
TM 9-213 ..... Painting Instructions for Field Use

A-4. Cleaning

C6800IL ..... Chemicals and Chemical Products
SB 725-7930-1 ..... Issue of Supplies and equipment Engineering Practices Study of Conus and Overseas Installation Requirements for Hard and Soft Water Cleaning Compounds.

A-5. Maintenance

FM 29-2 ..... Organizational Maintenance Management
CTA 50-970 ..... Expendable Items (Except Medical Class V. Repair Parts and Heraldic Items)
TB ORD-1031 ..... Purging, Cleaning, Inspecting and coating Interior Tanks and equipment on tactical and commercial type Fuel Tank, Trucks, and Trailers
TB 9-2800-236-50/1 ..... Reclamation of Crankshafts by Grinding Undersize
TB 750-97-61 ..... Maintenance Expenditure Limits for FSC Group 61, FSC Classes 6115, 6120, and 6125.
TB 43-180 ..... Calibration Requirements for Maintenance of Army Material
TB 750-255 ..... Uniform Policy for Hourmeters and Odometers on Overhauled or Repaired USAMECOM End Items of Equipment.
TM 5-6100-201-ESC ..... Equipment Serviceability Criteria for Generator Set, Electric, Portable, GED, skid mounted 5KW, 120/208VAC, 1 and 3 phase 60 HZ, hot-Garmdis CE-55AC/WK6 and CE-56AC,SF-5.0-MD International Fermont MDL,J-117, SF-5.0 MD, ONAN//MDL 5 GF-8xR/3100,5KW,400HZ,HF5.0-MD on an M DL 5GFE-408 XR/3101A, HOL-GARMDLCE-87 400-AC
TM 9-6140-200-12 ..... Operator and Organizational Maintenance Manual for Lead-Acid Batteries.
TM 11-483 ..... Radio Interference Suppression.
TM 38-750 ..... The Army Maintenance Management System (TAMMS)

TM 5-6115-574-20P .....Organizational Maintenance Repair Parts and Special Tools Lists: Generator Set, Diesel Engine, 100 KW, 0.8 PF, AC, 120/208 - 204/416V, 3 Phase, 60 Hertz, Convertible to 75 KW, 0.8 PF, AC, 110/190 - 220/380 V, 50 Hertz, Skid Mounted (Fermont Model MB-16) NSN 6115-00-081-2030

TM 5-6115-574-35P .....Direct Support, General Support and Depot Maintenance Repair Parts and Special Tools Lists: Generator Set, Diesel Engine, 100 KW, 0.8 PF, AC, 120/208 - 204/416 V, 3 Phase, 60 Hertz, Convertible to 75 KW, 0.8 PF, AC, 110/190 - 220/380 V, 50 Hertz, Skid Mounted (Fermont Model MB-16) NSN 6115-00-081-2030

A-6. Shipment and Storage

SB 38-100 .....Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army

SB 740-1 .....Storage and Supply Activities, Covered and Open Storage

TM 740-90-1 .....Administrative Storage of Equipment

A-7 Demolition

TM 750-244-3 .....Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command).

8. Operation

TM 5-766 .....Electric Power Generation in the Field

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25D (qty rqr block no. 1066), Organizational maintenance requirements for Generator Sets, Engine Driven 100 KW, 60 HZ, Precision Power.

TECHNICAL MANUAL
No. 5-6115-574-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *20 June 1972*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE: 100 KW, 0.8 PF, AC, 120/208-204/416V, 3 PHASE, 60 HERTZ, CONVERTIBLE TO 75 KW, 0.8 PF, AC, 110/190-220/380V, 50 HERTZ, SKID MOUNTED (FERMONT MODEL MB-16) FSN 6115-081-2030

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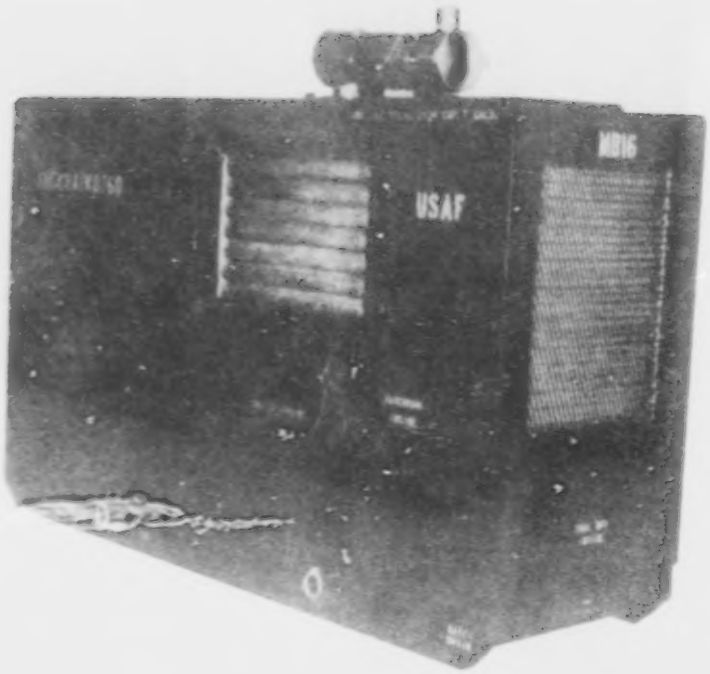


Figure 1-2. MB16 Engine-Generator Set, Skid-Mounted

PART I
OPERATOR'S AND ORGANIZATIONAL MAINTENANCE
SECTION I
INTRODUCTION AND DESCRIPTION

1-1. Scope. This manual is for use in operating and maintaining the skid mounted MB-16 engine generator set (fig. 1-2).

1-2. Maintenance Forms and Records, and Publication Improvements.

1-2.1. Maintenance forms and records that are required for use are explained in TM 38-750.

1-2.2. The reporting of errors, ommissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to: Commanding General, US Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Blvd. St. Louis, MO 63120.

1-3. Destruction of Army Materiel to Prevent Enemy Use. Procedures for the destruction of Army materiel to prevent enemy use are explained in TM 750-244-3.

1-4. Administrative Storage. Administrative storage procedures are described in TM 740-90-1.

1-5. PURPOSE OF EQUIPMENT.

1-6. The engine-generator set is used to furnish electrical power to aircraft and equipment shops under a wide variety of weather conditions for aircraft bombing, navigation, and communications equipment. The engine-generator set may also be used wherever electrical power of the type generated by this equipment is required.

1-7. LEADING PARTICULARS.

1-8. The major assemblies of the engine-generator set are the engine, generator, and control box. The physical and electrical characteristics of these assemblies are summarized in table 1-1.

1-9. DESCRIPTION.

1-10. The skid-mounted unit consists of an engine-generator set mounted on a skid base. The engine-generator set (figure 1-3) consists of an engine group, a generator group, a control system, a winterization system, and housing equipment.

1-11. BASE ASSEMBLY.

1-12. Deleted.

1-13. SKID-MOUNTED ENGINE-GENERATOR SET. The skid-mounted engine-generator set (figure 1-2) is mounted on a skid base. The skids run lengthwise along the length of the unit with cross braces welded to the skids for rigidity.

1-14. ENGINE GROUP.

1-15. ENGINE. (See figures 1-4 and 1-5.) The prime mover for the engine-generator set is a standard four-stroke, six cylinder, overhead-valve, full-fuel diesel engine capable of operating on either Diesel Fuel VV-F-800 or Jet Aircraft Fuel MIL-F-56 4. The engine uses natural aspiration. The engine group consists of a cooling system, a fuel system, a lubrication system, a cranking (starting) system and a battery-charging system.

1-16. COOLING SYSTEM. The engine-generator set utilizes a Pusher Type belt-driven fan to circulate cooling air through the generator-set housing. Air is drawn through louvres in one of the panel doors at each side of the housing, and exhausted through the radiator assembly at the front of the unit. This action removes ambient engine-generator heat at the same time that it removes heat from the radiator assembly. The forced circulation, air-cooled coolant system has a capacity of 13.5 gallons. A belt driven water pump, mounted in the front portion of the engine, forces coolant to circulate through the engine water jackets and tubes of the radiator assembly. At the top and bottom of the radiator are openings which permit coolant filling and draining. The filler cap contains a relief valve which lifts the lower part of the filler cap from its seat to allow excess pressure to escape through an overflow pipe. A thermostat, mounted on top of the engine, maintains constant temperature.

1-17. A thermostatically controlled shutter assembly mounted in front of the radiator also aids in maintaining constant coolant temperature. A thermostat and power unit assembly located underneath the radiator are used to control the opening of the shutters. The thermostat senses radiator coolant temperature and operates the power unit which drives a mechanical linkage connected to the shutter louvres. The shutter louvres start to open when coolant temperature reaches 145° and are fully opened when coolant temperature reaches 170° F. If the ambient temperature is expected to fall below 0° C.(32° F.) antifreeze solution must be added to the engine coolant solution. Refer to Section III for coolant quantities.

1-18. FUEL SYSTEM. (For the functional block diagram of the fuel system, refer to figure 1-6.) The fuel system provides the diesel engine with the correct amount of fuel and at the correct pressure. The fuel system consists of a fuel injection pump, fuel filters, a set (or storage) fuel tank, and three electric fuel pumps. The set fuel tank, a large metal container, is supplied with fuel through a filler neck and strainer at the top. An electrical sending unit at the top of the set tank transmits fuel level information to a fuel level gage on the engine-generator set control panel. The fuel is carried, by gravity, through a cock valve fuel filter network to the fuel injection pump. The fuel filter network consists of two cartridge filters, in series, on a bracket which is mounted on the housing framework.

1-19. The fuel injection pump is constructed of two main parts; a pump, to draw fuel from the set tank and deliver it to the fuel injectors, and the throttle and electric governor to control fuel flow. The pump is coupled to, and driven by, the fuel pump drive, as is a tachometer shaft which comes out of the top of the fuel injection pump and is connected to centrifugally-operated speed sensing switches. The actuator valve assembly, which adjusts engine speed by varying the amount of fuel delivered to the fuel injectors, is controlled by an electric governor. The actuator valve controls engine speed by varying the amount of fuel delivered to the fuel injectors.

1-20. The electric speed control governor system provides practical isochronous operation of the diesel engine. The system consists of a magnetic pickup, an electronic control unit, a frequency trim potentiometer, an actuator assembly, and a load sharing assembly. The magnetic pickup senses engine speed, the control unit compares this speed with the desired speed, and the actuator assembly operates a metering valve to compensate for any differences. The frequency trim potentiometer permits control panel adjustment of the governed speed, and the load sharing assembly permits parallel usage of two engine-generator sets.

1-21. Fuel flows from the set tank (figure 1-6), through the fuel filters and fuel control valve to the fuel injection pump. The fuel injection pump brings the fuel up to the proper pressure and feeds it to the engine fuel injectors. The fuel control valve is energized during engine starting. If an engine fault occurs, the valve closes, shutting down the engine. The timing of the fuel injectors is controlled by a camshaft, located within the engine block and driven through timing gears by the engine. Excess fuel from the fuel injectors is carried to a common low-pressure header and then returned to the set tank by force of gravity. A low fuel pressure switch shuts down the engine when fuel pressure falls below 35 ±5 psi.

1-22. If the fuel requirements of the engine-generator set are to be supplied from an auxiliary source instead of from the set tank, the AUX FUEL PUMP switch, on the engine-generator set control panel, is set to ON. With the fuel system setup in this manner, fuel is pumped, by an electrically-operated pump, from the auxiliary source to the fuel system set tank. From the set tank, the fuel is processed in the manner described in paragraphs 1-18 through 1-21. Fuel flow to the set tank is controlled by a fuel level control assembly which automatically shuts off the auxiliary fuel pump when the set tank is approximately 3/4 full, and starts the pumps automatically when the set tank is approximately 1/4 full.

NOTE

If the auxiliary fuel source is located above the set tank, an electric solenoid shut-off valve must be installed.

1-23. LUBRICATION SYSTEM. Engine lubrication is accomplished by a pressure-regulated, gear-type pump and filter which force feeds the moving parts of the engine with oil drawn from the sump in the crankcase oil pan. This oil is delivered throughout the engine by means of lubricating oil lines and the oil header, which is drilled the full length of the engine block. Filters, strainers, and screens are provided throughout the system for proper cleaning of the lubricating oil. The lubricating oil is cooled by allowing a portion of the lubrication system to pass through the coolant system. This is accomplished by the lubrication oil cooler which is mounted at the front of the engine. A by-pass valve assures proper flow of oil in the event the oil filters become clogged. A crankcase breather on top of the engine allows oil vapors to escape safely to the atmosphere. A dipstick-type oil gage and oil filler port with cap are mounted on the left side of the engine block to check the level of the lubricating oil.

1-24. CRANKING SYSTEM. The cranking system consists of a 24-volt starter motor capable of developing extremely high initial torque, starting motor accessories, two series-connected 12-volt storage batteries and a starter disconnect overspeed switch. The batteries, secured in the battery box, supply power to the starter motor through the battery cables and a starting solenoid. When the engine starts and attains an operating speed of 600 rpm or higher, the starter disconnect overspeed sensing switch automatically cuts out the cranking circuit to prevent damage to the starter motor after the engine has started. The batteries also supply d-c power for the engine control system.

1-25. BATTERY-CHARGING SYSTEM. The battery-charging system consists of a transformer-rectifier power supply, and a BAT CHGR switch and battery charging ammeter located on the control panel. Either a high charging current (3 to 5 amperes) or a trickle charge, depending upon the position of the BAT CHGR switch, is fed to the batteries. The battery charging ammeter is used to monitor the battery charging current. A battery charging receptacle on the left side of the skid permits the connection of an external 28 (or 24) volt d-c power supply to the engine-generator set in case of insufficient battery starting power.

NOTE

This receptacle may also be used to connect a 28 (or 24) volt d-c external source to recharge the engine-generator set storage batteries during inoperative periods.

1-26. After an emergency start, the external power may be disconnected since the engine-generator set can supply the necessary d-c power for the engine control circuits and battery recharging.

1-27. GENERATOR GROUP.

1-28. The generator group is located at the rear of the engine-generator set (figure 1-7). The major components of the generator group are the a-c generator and exciter, the voltage regulator (located in the control box assembly), and associated circuits; meters and switches. Electrical safety control devices disconnect the generator load and open the exciter field circuit if certain faults develop within the generator group.

1-29. A-C GENERATOR AND EXCITER. The a-c generator and associated exciter are mounted on the same drive shaft and contained in a common cast iron housing. The entire unit is mounted on beams just behind the control box assembly. The beams are supported by the skid base. An eye bolt at the top of the housing provides a means for lifting the unit. Six silicon rectifiers, mounted on the exciter armature, provide the d-c voltage necessary to excite the generator field. To eliminate the need for brushes, and their subsequent wear, the generator field is made the rotating element (rotor) and the armature is the stationary element (stator).

1-30. VOLTAGE REGULATOR. The voltage supplied to the field of the exciter is controlled by a voltage regulator mounted inside the control box assembly. The regulator automatically maintains the output of the generator at a constant value under varying load conditions.

1-31. WINTERIZATION SYSTEM.

1-32. FUEL BURNING HEATER. During conditions of extreme cold weather, -31° to -54°C (-25° to -65°F), it is necessary to use the fuel burning heater winterization equipment to start the engine-generator set. Refer to figure 1-8 for the functional block diagram of the fuel burning heater winterization system. Fuel from the set tank is pumped by the electric fuel pump into the fuel burning heater through the heater fuel solenoid valve, and a heater strainer.

TABLE 1-1. ENGINE-GENERATOR SET LEADING PARTICULARS

Equipment	Characteristics
Engine-Generator Set	Output: 100 kw, 0.8 power factor, 60 Hz, 120/208 or 240/416 volts ac. Convertible to 75 kw, 50 Hz, 110/190 or 220/380 volts ac.
	Height: Approximately 72 inches (skid-mounted)
	Width: Approximately 40 inches (skid-mounted)
	Length: Approximately 117 inches (skid-mounted)
	Gross Weight: Approximately 6570 lbs (dry) (skid-mounted)
	Radio Interference Suppression: As per MIL-I-11683
	Temperature Operating Range: -65° to +125°F
	Fuel Capacity: Set Tank 69.5 gallons
	Continuous Operation without Refueling: 8 hours
	Coolant Capacity: 13.5 gallons
	Battery: Two 12 volt batteries connected in series:
	Ground: Negative terminal
	Electrolyte: Sulphuric Acid (Specification O-S-801)
	Electrolyte Capacity: 16.4 quarts (each battery)
	Specific Gravity: 1.280 ±0.005 at 25°C (77°F)
	Overload Capacity: 125% for 10 min.
Engine	Manufacturer and Model: Cummins Engine Company Model NH220 (Modified)
	Engine breathing: Natural Aspiration
	Number of Cylinders: 6
	Bore and Stroke (inches): 5-1/2 x 6
	Cylinder Cubic Inch Displacement: 743
	Valves per Cylinder: 4
	Maximum Horsepower: 220 at 1800 rpm
	Lubricating Oil Capacity: 7 gallons
	Air Cleaner Oil Cup Capacity: 1 gallon
	Starting: Electric motor
Generator	Manufacturer and Model: Kato Engineering Co. 101 Modified (Code A)
	Manufacturer and Model: General Electric Co. - 5SJ4444P21Y4 (Code B)

TABLE 1-1. ENGINE-GENERATOR SET LEADING PARTICULARS (Continued)

Equipment	Characteristics
Generator (cont)	NOTE Some Model MB16 Generator Sets contain a General Electric generator in lieu of a Kato generator. Power Factor: 0.8 Output Voltage (60 Hz): 120/208 or 240/416 volts ac, 3-phase, 4-wire at 1800 rpm Output Voltage (50 Hz): 110/190 or 220/380 volts ac, 3-phase, 4-wire at 1500 rpm

1-33. The fuel burning heater is strap-mounted to the framework of the housing equipment near the right front portion of the engine. The fuel burning heater heats air by passing it through a metal chamber which has been heated by the flames of burning fuel. The heated air is then channeled, by means of flexible tubing to the battery box where it heats the batteries for more efficient starting, and to the crankcase through the air heater valve, where it heats the lubricating oil. A thermal switch is provided in the battery box to maintain the lube oil and battery box temperatures between 4.4° and 43°C (30° and 110°F±5°F). The exhaust gases from the fuel burning heater are also used to heat the lubricating oil by passing the exhaust gases through a coil of metal tubing submerged in the lubricating oil at the bottom of the crankcase. The exhaust gases are then allowed to escape to the outside atmosphere.

1-34. ELECTRIC HEATERS. During less-severe weather conditions, and with an external 120-volt, 60-Hz, a-c power source available, the warming of the lubricating oil, and coolant is accomplished by two electric immersion heaters (figure 1-9). When the ELEC HTR switch on the control panel is operated, two heating elements within the immersion heaters (located at the bottom of crankcase oil pan) heat the engine coolant which has been channeled through the immersion heaters. The engine coolant heats the walls of the immersion heaters which, in turn, heat the lubricating oil. The heated coolant, forced to circulate by the conduction developed within the immersion heaters, warms the engine block and all other parts which come in contact with the heated coolant. The batteries in the battery box are heated by two strip heating elements mounted on the inner walls of the battery box. After the engine has started and the generator is delivering power, the external power source is disconnected and the battery box strip heaters can remain energized by the generator power.

1-35. HOUSING EQUIPMENT.

1-36. The housing equipment serves to enclose and protect the engine, the generator, and all the accessory equipment required to operate the engine-generator set. The housing equipment consists of metal paneling, metal panel doors located on each side of the generator set, and a framework which supports the metal paneling and doors. The panel doors, which are hinged at the top and in the center, flap over and are held open by mating hooks welded to the bottom of the panel door and the housing roof. The forward door on each side of the generator set contains thermostatically controlled shutters which control ventilation to the generator set. A thermostat mounted inside the housing senses engine-generator ambient temperature. A power unit mechanically linked to the shutters opens the shutters when engine-generator ambient temperature reaches 55°F. The shutters are fully open when the engine-generator ambient temperature reaches 80°F. On the roof of the housing equipment are several covered openings which permit access to the top portions of the engine-generator set.

1-37. TOOL BOX ASSEMBLY.

1-38. The tool box assembly is located underneath the radiator assembly. The tool box serves as a storage area for spare parts, field-maintenance type tools, and for parts which are removed during maintenance procedures.

1-39. RECONNECTION PANEL AND LOAD ASSEMBLY.

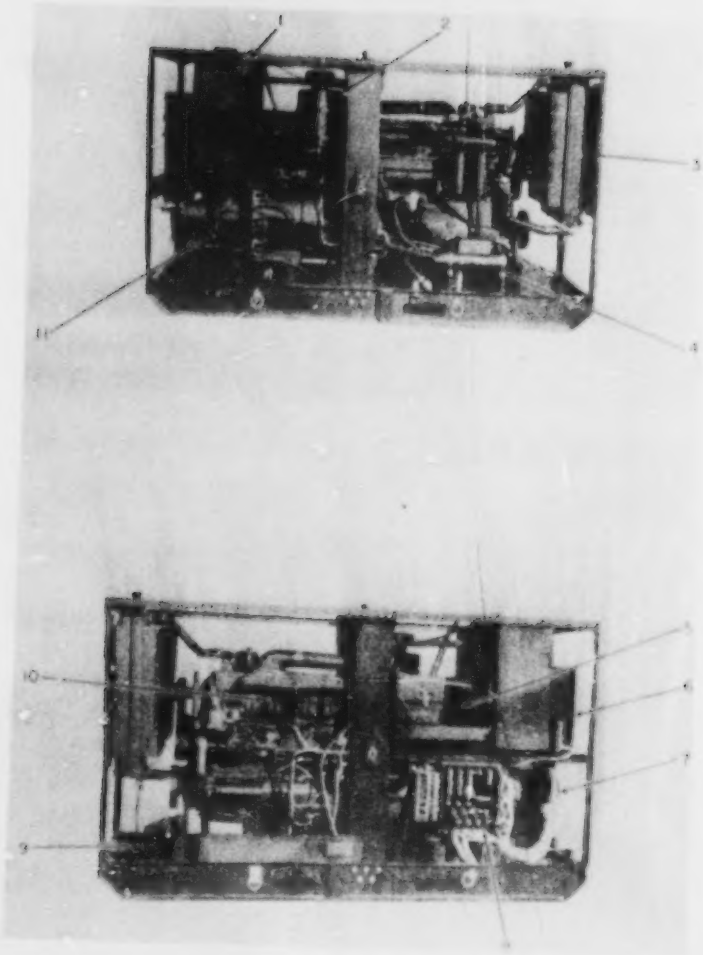
1-40. The reconnection panel and load assembly (figure 1-7) is located at the left rear-end of the engine-generator set. This assembly consists of the reconnection panel, terminal boards TB1, TB2, and TB3 and transformers T1 through T4. The reconnection panel is provided to connect the generator output of the engine-generator set to the load, and to connect the engine-generator to another unit during parallel operation. Terminal boards TB1 and TB2 are provided to connect the engine-generator set to a remote transfer panel when remote or automatic operation of the engine-generator set is desired. Terminal board TB3, located behind the reconnection panel, is provided to connect the output terminals of the generator to the reconnection panel. Transformers T1, T2 and T3 are current transformers used to sense generator current, and transformer T4 is a cross current transformer used in load sharing during parallel operation. Link bars are connected to terminals on the reconnection panel to provide a generator output of 120/208 or 240/416 volts ac at 60 Hz, or 110/190 or 220/380 volts ac at 50 Hz.

NOTE

Jumpers on the terminal boards TB1 and TB2, normally in place during local or manual operation, have to be removed prior to remote operation.

1-41. CONTROL BOX ASSEMBLY.

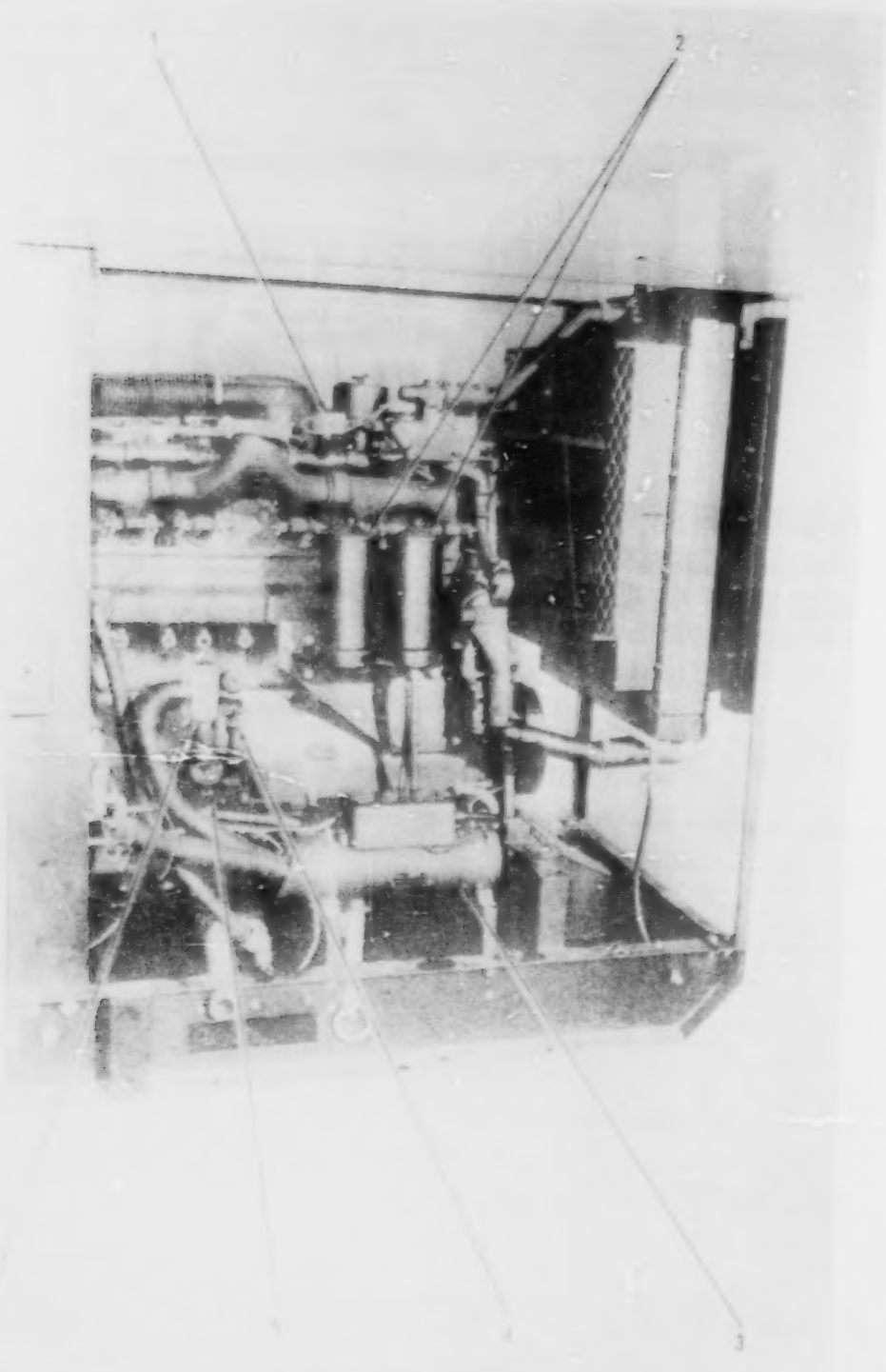
1-42. The control box assembly is located at the rear of the engine-generator set. The front panel of the assembly contains the switches, controls, and indicators necessary for the operation



Key to Figure 1-3

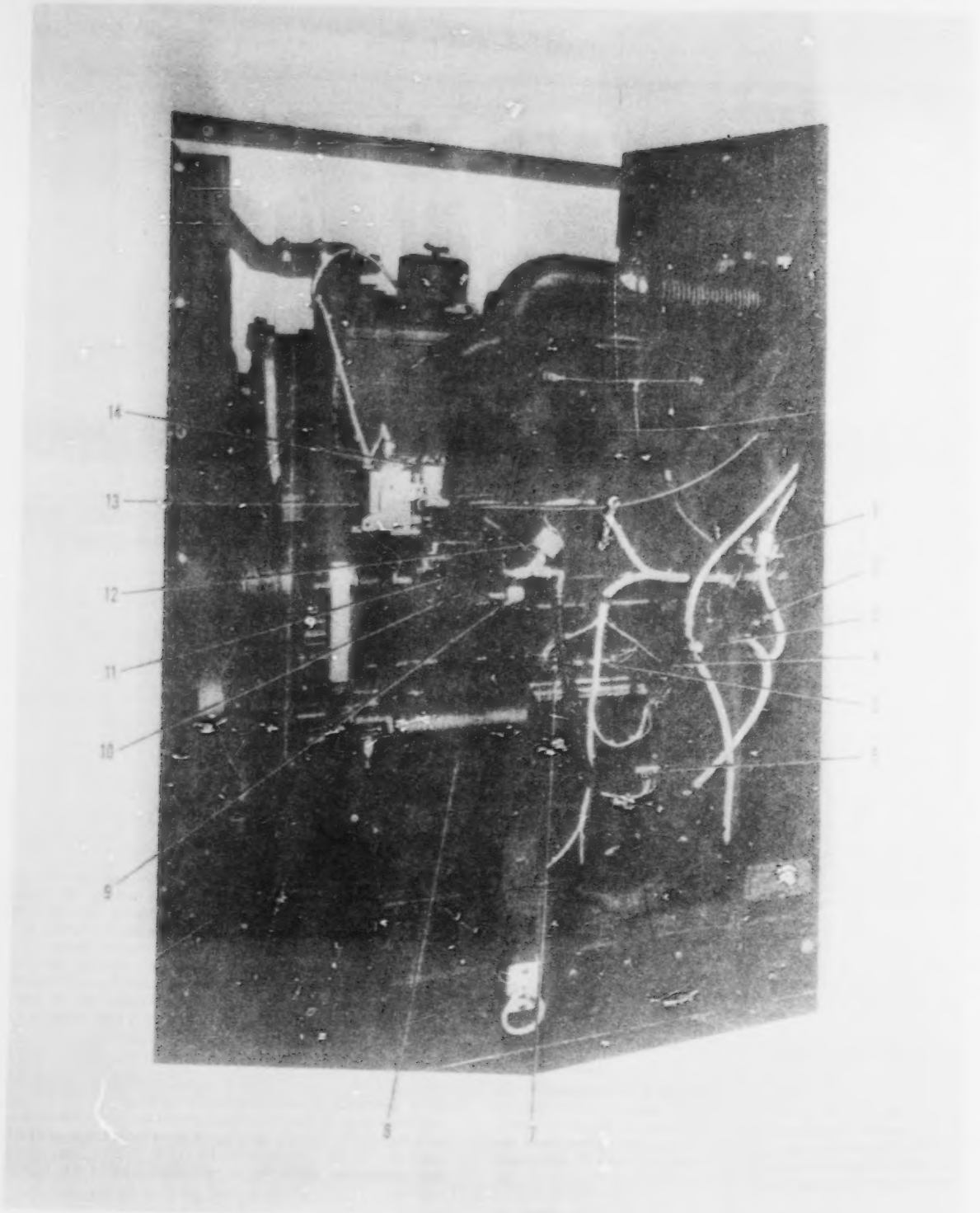
1. Fuel System Installation
2. Air Cleaner Installation
3. Radiator and Shutter Assembly
4* Fuel Burning Heater
5. Battery Installation
6. Control Box Assembly
7. Contactor Installation
8. Load and Reconnection Assembly
9. Tool Box
10. Diesel Engine
11. Generator

Figure 1-3. Engine-Generator Set, Major Assemblies



1. Thermal Switch S21
2. Lubrication Oil Filters
3. Fuel Burning Heater HR3
4. Dipstick
5. Oil Filler
6. Heater Air Valve

Figure 1-4. Diesel Engine, Right Front View



1. Starter Motor Slave Relay K28
2. Starter Motor Relay K1
3. Engine Starter Motor B1
4. Lube Oil Pressure Transmitter E1
5. Lube Oil Pressure Switch S8
6. Starter Engage Relay K30
7. Lube Oil Pressure Switch S2
8. Lube Oil Filter
9. Fuel Pressure Switch S17
10. Fuel Injection Pump
11. Fuel Solenoid Valve L1
12. Fuel Shut-Off Solenoid Valve L3
13. Electronic Governor Actuator EG1-A
14. Speed Sensing Switches S1 & S7

Figure 1-5. Diesel Engine, Left Front View

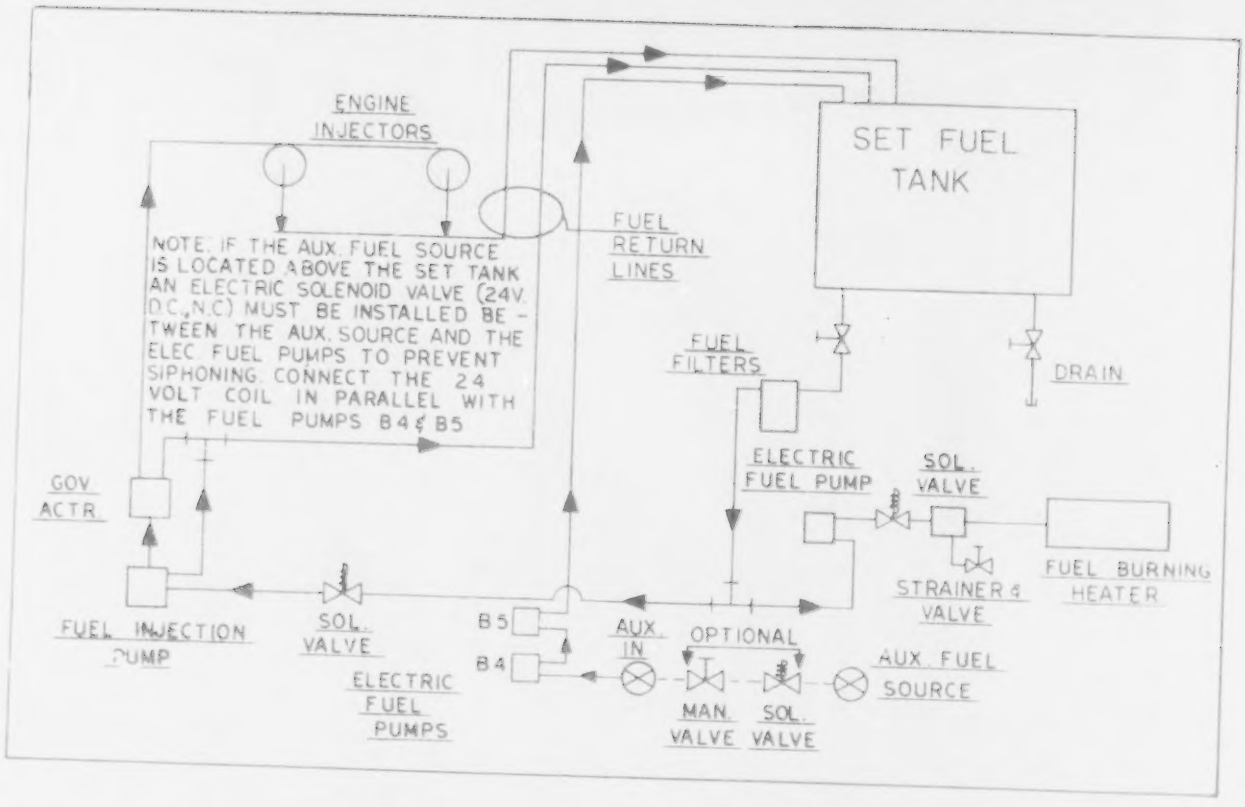

ENGINE INJECTORS
SET FUEL TANK
FUEL RETURN LINES
NOTE: IF THE AUX. FUEL SOURCE IS LOCATED ABOVE THE SET TANK AN ELECTRIC SOLENOID VALVE (24V. D.C., N.C) MUST BE INSTALLED BE - TWEEN THE AUX. SOURCE AND THE ELEC. FUEL PUMPS TO PREVENT SIPHONING. CONNECT THE 24 VOLT COIL IN PARALLEL WITH THE FUEL PUMPS B4 & B5
FUEL FILTERS
DRAIN
ELECTRIC FUEL PUMP
SOL. VALVE
GOV. ACTR.
FUEL BURNING HEATER
STRAINER & VALVE
FUEL INJECTION PUMP
SOL. VALVE
B5
B4
AUX. IN
OPTIONAL
AUX. FUEL SOURCE
ELECTRIC FUEL PUMPS
MAN. VALVE
SOL. VALVE

Figure 1-6. Fuel System, Functional Block Diagram

the engine-generator set. The inside of the control box assembly (figure 1-10) contains relays, fuses, voltage regulator, and a wattmeter converter necessary for the operation, control, and monitoring of the engine-generator set.

NOTE

With the exception of the kilowatt meter, the control boxes are identical on all engine-generator sets.

1-43. CONTROL SYSTEM.

1-44. An automatic safety control system is incorporated in the engine-generator set to protect the unit against possible damage due to engine or generator faults. The engine is protected against low lubricating oil pressure, overspeed, high coolant temperature, and low fuel pressure; the generator is protected against overvoltage, undervoltage, overcurrent, overload, underfrequency and short circuit.

1-45. When an engine fault occurs, the engine is shut down by shutting off the fuel supply, and the generator is disconnected from the load. When a generator fault occurs, the engine continues to operate, but the generator load is disconnected and the exciter-field is inhibited. For each fault, except low fuel pressure and overload, an associated red warning light on the control panel lights to indicate the type of trouble.

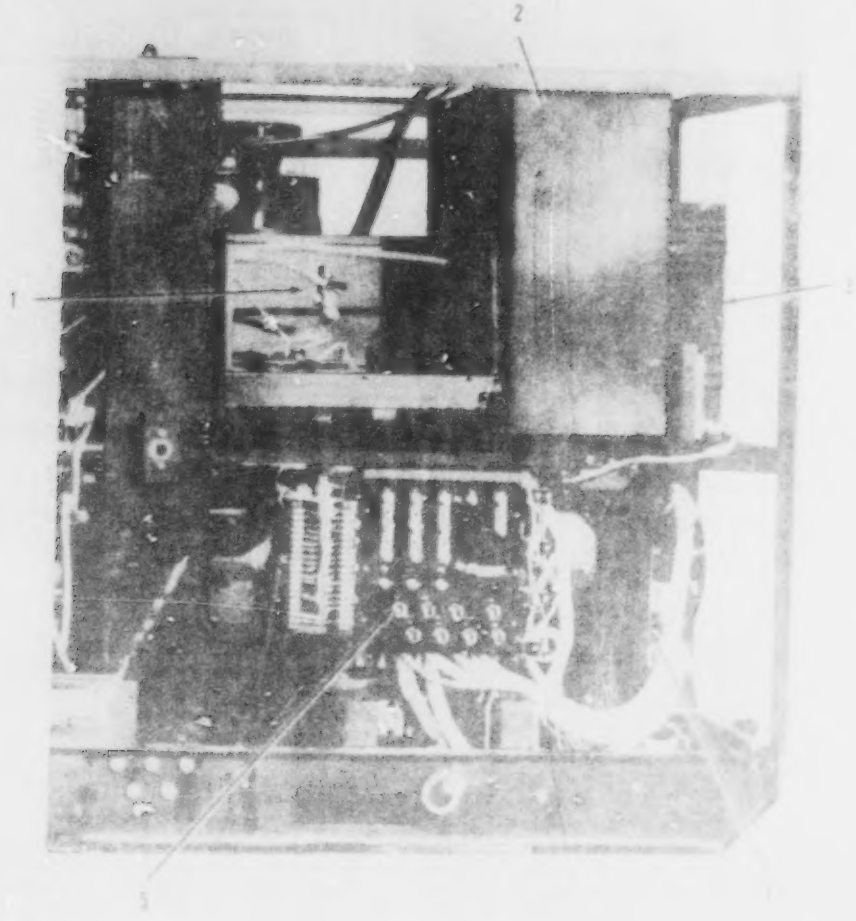
1-46. PRINCIPLES OF OPERATION.

1-47. Principles of operation of the engine-generator set are contained in the following paragraphs. To aid in the discussion, operation of the engine-generator set is divided into the following functions: engine starting circuits, engine fault circuits, generator fault circuits, battery charging circuits, electric heater operation, engine speed control circuit, panel and trouble light circuits, generator and exciter-generator control circuits, and reconnection panel and synchronizing circuits. As a further aid, an associated simplified schematic diagram is referred to in each discussion.

1-48. ENGINE STARTING CIRCUITS.

1-49. GENERAL. Depending upon temperature, the fuel burning heater is used to start the engine-generator set. If the temperature is below -32°C (-25°F), the fuel burning heater is energized before starting. If the temperature is -32°C (-25°)F or above, the engine-generator set is started without the aid of the fuel-burning heater.

1-50. FUEL BURNING HEATER OPERATION. (See figure 1-11.) The fuel burning heater is energized by setting FUEL BRNG HTR switch S13 on the control panel to the ON position. Switch contacts S13-1 apply 24 volts dc from batteries BT1 and BT2 to energize heater fuel solenoid L2. The 24 volts dc is also applied through normally closed A contacts of engine operating relay K6



1. Battery Box
2. Fuel Tank
3. Control Box
4. Contactor Installation
5. Load and Reconnection Panel

Figure 1-7. Engine-Generator Set, Left Rear View

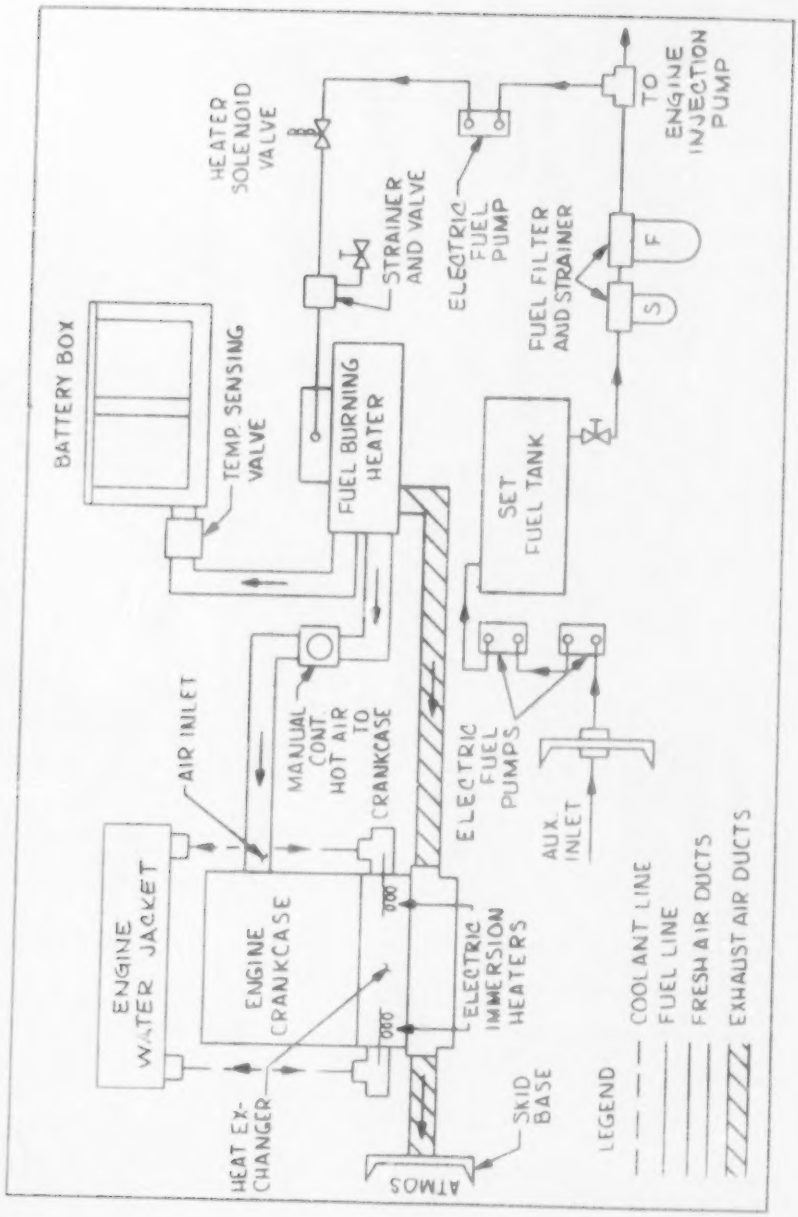


Figure 1-8. Winterization System, Fuel Burning Heater, Functional Block Diagram

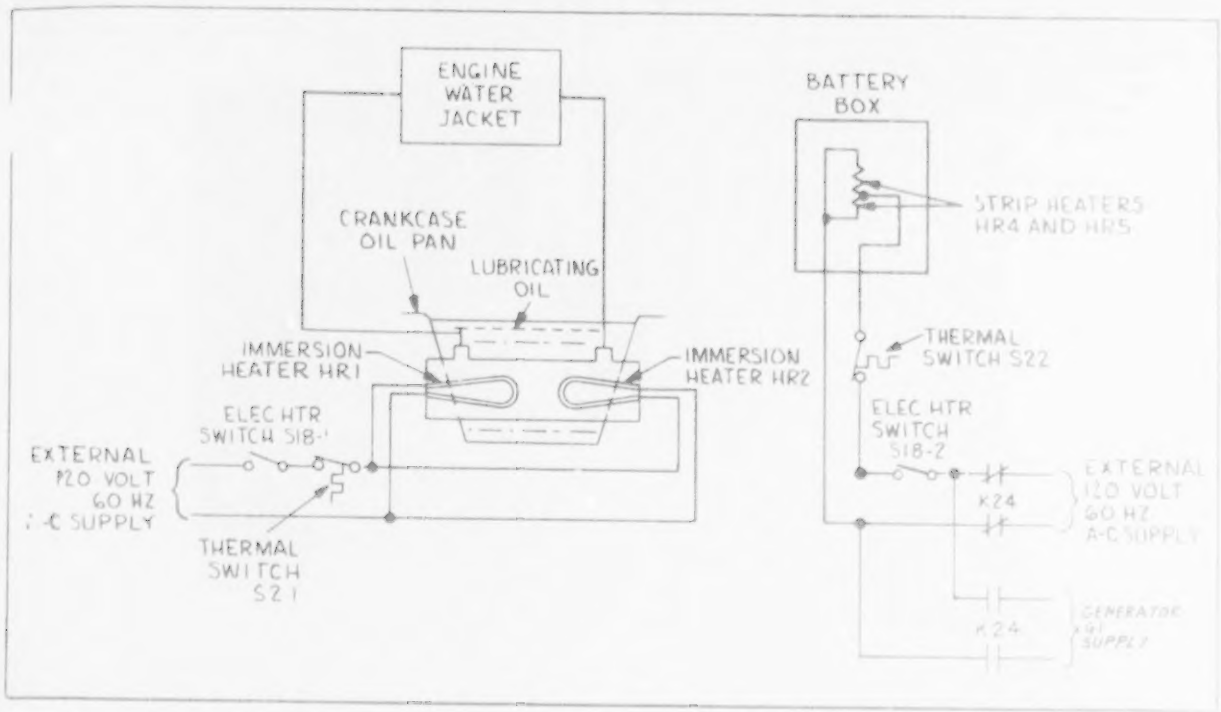
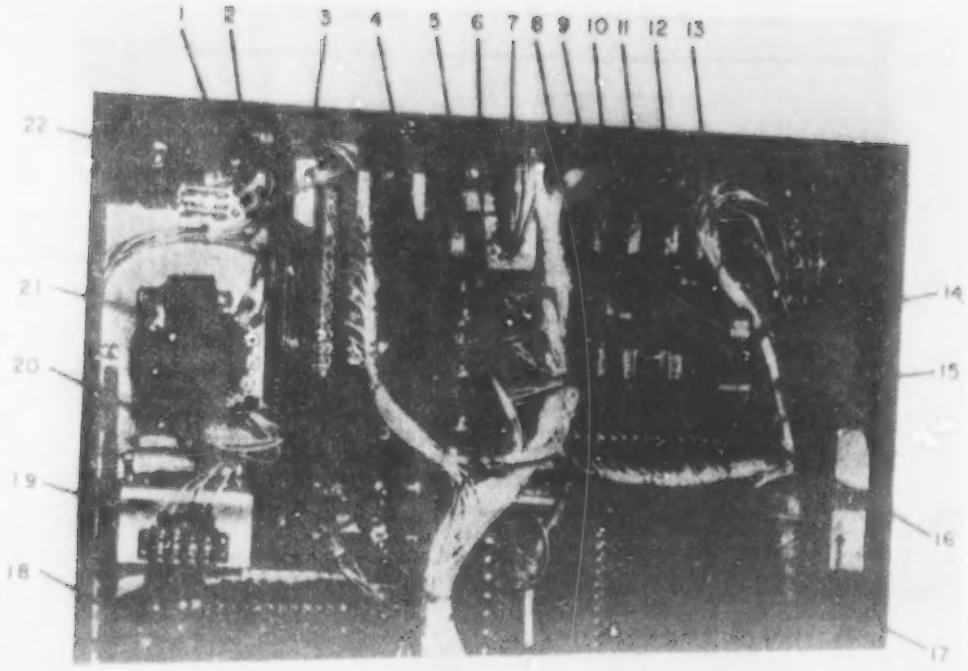


Figure 1-9. Winterization System Immersion and Battery Box Strip Heaters, Functional Block Diagram

and fuel burning thermal switch S14 to electric fuel pump motor B3 and to terminal 8 of fuel burning heater HR3. (The letter designations assigned to contacts of relays in the control system are arbitrarily assigned for identification purposes only.) The d-c voltage from thermal switch S14 is also applied through contacts S13-2 of the FUEL BRNG HTR switch (ON position) to auxiliary fuel pump control relay K31, which controls the operation of auxiliary fuel pump motors B4 and B5. With the energizing of heater fuel solenoid L2 and electric fuel pump motor B3, fuel is pumped from the fuel tank through the open heater solenoid valve to the fuel burning heater. Diode CR16 prevents the d-c voltage from being applied to the engine starting circuits.

1-51. The 24 volts dc applied to the fuel burning heater is transferred through the normally closed heater overheat thermal switch to the heater fuel shut-off solenoid. When the solenoid becomes energized, the heater fuel solenoid valve opens permitting fuel to enter the heater through a standpipe. The 24 volts dc is also applied through two fuel preheating elements and the normally closed flame switch to the glow-plug igniter. The preheating elements are placed around the standpipe and serve to preheat the fuel during the heater starting period. This preheating action raises fuel temperature to insure vaporization and immediate ignition, even under the coldest conditions. The 24 volts dc is also applied through one of the preheating elements and the flame switch to the heater blower motor. This cause the blower, which supplies air for combustion and ventilation, to operate at slow speed. When the igniter becomes energized, the vaporized fuel ignites, the flame is established in the heater. As soon as the flame is established, the resulting hot gases cause the flame switch to expand and open. This removes the 24 volts dc energizing voltage from the igniter, and the igniter is shut off. At the same time, the blower receives the entire 24 volts dc battery voltage through the operated flame switch, causing the blower to speed up and to deliver the full operating volume of ventilating and combustion air. Since the igniter is shut off and the preheating element bypassed by the open flame switch, the standpipe is now heated by combustion in the heater. The heater is now in full operation and will continue to burn as long as fuel, d-c current, and air are supplied. In the event that the heater should become overheated for any reason, the overheat thermal switch, connected in series with the heater fuel shut-off solenoid, opens, deenergizing the solenoid. As a result, the heater fuel shut-off valve closes, shutting off fuel to the heater, thus shutting down the heater.

1-52. During operation of the heater, the crankcase valve is set to HEATER, and hot air is ducted to the diesel engine and to the battery box. The temperature of the oil is controlled by fuel burning heater thermal switch S14. When the temperature of the oil reaches 12.7°C (55° ±5°F), thermal switch S14 opens, removing the 24 volts dc energizing voltage from the fuel burning heater. This shuts down the heater by shutting off the flow of fuel to the heater and deenergizing the heater ignition system. When the temperature of the oil drops to 1.6°C (35° ±7°F), thermal switch S14 will automatically close again causing the fuel burning heater to cycle on. The temperature of the oil is thus maintained between these limits. After the heater is in full operation for a minimum of



1. Fuse F2
2. Fuse F1
3. Kilowatt Transducer D1
4. Short Circuit Relay K27
5. Short Circuit Relay K26
6. Short Circuit Relay K10
7. Engine Operating Relay K6
8. Battery Charger and Heater Relay K24
9. High Coolant Temperature Fault Relay K7
10. Pilot Starter Motor Relay K2
11. Exciter Field Control Relay K9
12. Overspeed Fault Relay K8
13. Low Lube Oil Pressure Fault Relay K18
14. 1 Second Delay Generator Fault Lockout Relay K23
15. 10 Second Delay Engine Run Relay K3
16. Master Engine Lockout Relay K4
17. Voltage Regulator Subassembly VR1
18. Voltage Frequency Monitor K13
19. Transformer Rectifier Subassembly A1
20. Battery Charger Rectifier CR1
21. Battery Charger Transformer T6
22. Speed Droop Adjust R3

Figure 1-10. Control Box Assembly, Internal View

one hour, the FUEL BRNG HTR switch is placed to the OFF position, causing the fuel burning heater to shut down. The blower will continue to operate, however, until the flame switch returns to its normal position. The diesel engine is now ready for normal starting.

1-53. STARTING CIRCUITS. (See figure 1-11.) When the engine-generator set is put in operation, D.C. SYS CKT BKR (CB3) on the control panel is set to ON. This applies 28 volts dc to AUX FUEL PUMP switch S27 and START-AND OPERATE switch S28. Both switches are located on the control panel. Switch S28 is set to the appropriate position, depending upon the desired operation. If nonattended operation is desired (utilizing auto start nonattached power transfer panel), the switch is set to the AUTO & REMOTE position. (When this type of operation is to be used, jumper wires on terminal boards TB1 and TB2 must be removed. Refer to the overall schematic diagram, figure 6-3.) When the engine-generator set is to be operated and attended locally, switch S28 is set to the MANUAL & LOCAL position. From either switch position, 24 volts dc is transferred through normally closed A contacts of master engine fault lockout relay K4 to three different paths. One path is to fuel level gage M3 and low lube oil pressure gage M2, both located on the control panel. Diode CR17 prevents the d-c voltage from being applied to the auxiliary fuel pump control K31. The fuel level and oil pressure gages operate on electrical signals transmitted to the gages by appropriate sending units E2 and E1, respectively. A second path is to engine fuel shut-off solenoid L1 and L3. When these solenoids are energized, the engine fuel shut-off valves open allowing fuel to be delivered from the fuel injection pump to the engine fuel injectors. A third path for the 24 volts dc is through normally closed A contacts of speed sensing switch S1 to the STARTER DISC switch S31. (This switch should be in the NORMAL position except when maintenance is to be performed on the engine-generator set, at which time, the switch is set to the MAINT position. This is a safety feature which disconnects the starting circuit to prevent unintentional starting of the engine-generator set during maintenance periods.) From the STARTER DISC switch, the 24 volts dc is applied to the coil of field flashing relay K29. (Refer to paragraph 1-89 for operation of K29 contacts A, B, C, and D.) 24 volts dc is also applied through normally closed lube oil pressure switch S2 as energizing voltage for pilot starter motor relay K2. When relay K2 operates, 24 volts dc is transferred through operated A contacts of the relay to energize starter motor slave relay K28. With this relay energized, 24 volts dc is applied directly from the battery through operated contacts of relay K28 to the coil of starter motor relay K1. Operated contacts of this relay then apply the battery voltage to starter motor B1, and the engine starts to crank. In the event that the starter motor drive gear and flywheel ring gear do not engage, the contacts of relay K1 will not close. This applies a 24 volt d-c potential across the solenoid of relay K30, causing it to energize (ground return being provided by the low-resistance windings of B1). The normally closed contacts of K30 open, deenergizing starter motor slave relay K28, causing the entire starting sequence to recycle until the drive gear and ring gear engage properly. After the engine starts and reaches a speed of approximately 600 rpm, speed sensing switch S1 operates, causing its A contacts to open. This interrupts the 24 volt d-c circuit to the starter motor, and the starter motor stops cranking. Oil pressure switch S2 serves as a safety switch to prevent damage to the starter motor by not allowing the starter motor to become energized until the engine has come to a stop. Switch S2, which is open during engine operation, closes when lube oil pressure falls below 10 psi, thus resetting the starter motor circuit.

1-54. At the same time that speed sensing switch S1 operates, normally open B contacts of the switch close, and 24 volts dc is applied to elapsed time meter M1. The meter monitors the actual running time of the engine-generator set. The d-c voltage from the speed sensing switch is also applied to 10 second delay engine relay K3. After 10 seconds, relay K3 conducts and supplies 24 volts dc to the coil of engine operating relay K6, energizing this relay. This causes normally closed A contacts of relay K6 to open, disconnecting the 24 volt dc path to fuel burning heater HR3 and electric fuel pump motor B3. This is an additional safety factor to prevent inadvertent operation of the fuel burning heater while the engine-generator set is operating. In addition, normally open C contacts of relay K6 close at this time, permitting voltage to be applied to the generator load contactor coil.

1-55. In the event of an engine fault (low lubricating oil pressure, overspeed, high coolant temperature or low fuel pressure), master engine lockout relay K4 becomes energized due to 24 volts dc applied to the relay coil from the engine fault circuits. (Refer to paragraph 1-57.) This causes normally closed A contacts of the relay to open, disconnecting the 24 volts dc from the engine fuel shut-off solenoids L1 and L3. With solenoids L1 and L3 deenergized, fuel flow from the fuel injection pump to the engine fuel injectors is stopped and the engine-generator set shuts down. Elapsed time meter M1 is also deenergized at this time. In the event of a generator fault (over or undervoltage, underfrequency, or over current), 1 second delay generator fault lockout relay K23 biases relay K3 to cutoff, thereby deenergizing engine operating relay K6 and relay K24 in the battery charging circuit. If, an emergency requires continued operation of the engine-generator set, SAFETY BYP switch S5 on the control panel is placed from its NORM OPER position to the EMER OPER ONLY position. This action removes the ground return from the coil of engine fault lockout relay K4 and generator fault lockout relay K23, preventing faults from interrupting operation. When an externally located auxiliary fuel source is used to supply fuel to the engine-generator set, AUX FUEL PUMP switch S27 is set to the ON position. In addition, for auxiliary fuel operation, FUEL BRNG HTR switch S13 must be in the OFF position. This causes 24 volts dc battery voltage to be applied through auxiliary fuel pump control relay K31 to electric fuel pump motors B4 and B5. The electric fuel pumps then operate to pump the fuel from the auxiliary fuel source to the fuel supply set tank of the engine-generator set.

1-56. When the engine-generator set is to be operated from a remote transfer panel, the unit can be started either locally, after which operation is switched to the remote location, or started remotely. In local starting, prior to remote operation, START AND OPERATE switch S28 is set to the AUTO & REMOTE position after a remote start-stop control on the transfer panel is closed. This applies 24 volts dc to pilot starter motor relay K2, as previously described, for manual and local starting. In this case, however, relay K2 becomes energized due to the ground return applied to the relay through a normally closed remote engine crank timer control connected between terminals TB1-2 and TB1-4 of the engine-generator set. (A jumper wire connected between the two terminal boards must first be removed prior to the start.) When relay K2 becomes energized, B contacts of the relay operate to apply a ground return to a remote crank lockout circuit to start the remote crank timer control operating. The remote timer control is preadjusted to cycle on and off, alternately closing and opening the ground return path to pilot starter motor relay K2. If the engine does not start within the predetermined time, the timer control will cycle off, deenergizing relay K2 and deenergizing, in turn, the starter motor. Thus, the timer control serves to prevent excessive battery drain and possible damage to the starter motor by eliminating continuous cranking of the starter motor. After the engine has started, relay K2 is deenergized, disconnecting the starter motor. The ground return applied to the remote crank lockout circuit is also removed at this time. For remote starting, the START AND OPERATE switch is left in the AUTO & REMOTE position and the engine-generator set is started at the remote transfer panel by the closing of the remote start-stop control.

1-57. ENGINE FAULT CIRCUITS.

1-58. GENERAL. To protect the engine from damage, the engine-generator set is equipped with safety devices to

immediately shut down the engine and disconnect the generator from the load if one or more of the following engine faults occur: low lubricating oil pressure, overspeed, high coolant temperature, or low fuel pressure. An appropriate red warning indicator lamp on the control panel lights to indicate the area of malfunction and remains illuminated after the engine has shut down. (An exception to this, however, is in the low fuel pressure fault circuit, which has no indicator lamp.) The light can then be extinguished by depressing the SAFETY RESET pushbutton on the control panel after the malfunction has been corrected.

1-59. LOW LUBRICATING OIL PRESSURE FAULT CIRCUIT. (See figure 1-13.) During normal operation of the engine-generator set, 10 second delay engine run relay K3 is conducting as a result of 24 volts dc applied to the relay from the engine starting circuits. With relay K3 conducting, 24 volts dc is applied through the relay to the coil of engine operating relay K6, causing normally open B contacts of the relay to close. This allows 24 volts dc to be applied through SAFETY RESET pushbutton S9, and normally closed A contacts of exciter field control relay K9, to low lube oil pressure switch S8. If the engine continues to operate normally, engine lubricating oil pressure will be approximately 60 psi, causing normally closed lube oil pressure switch S8 to be open. As a result, the 24 volts dc required to activate the low lubricating oil pressure fault circuit will be inhibited, and the circuit will remain deenergized. If, however, lubricating oil pressure falls below 10 psi, low lube oil pressure switch S8 closes, causing 24 volts dc to energize the coil of low lube oil pressure relay K18 and illuminate LOW LUBE OIL PRESS indicator lamp DS24 (and remote low lube oil pressure indicating lamp, if connected). This closes the A and B contacts of K18. The A contacts now provide a holding circuit for K18, and the relay will not deenergize even if S8 should open. When contacts of relay K18 close, 24 volts dc is transmitted to the coil of master engine fault lockout relay K4. With this relay now energized, normally closed A contacts of the relay open, removing the energizing voltage from engine fuel shut-off solenoid L1, causing the engine to shut down. Normally closed C contacts of relay K4 also open at this time, inhibiting the voltage applied to the generator load contactor coil. As a result, the generator is disconnected from the load. As an additional safety factor, the generator is also disconnected from the load during an engine fault by the opening of the A contacts of relay K4 which causes engine run relay K3 to stop conducting. When relay K3 cuts off, engine operating relay K6 also deenergizes, causing its C contacts to open. Since these contacts are also part of the generator load contactor circuits, the circuits are inhibited. In addition, normally open B contacts of relay K4 close, providing a holding circuit for K4. START AND OPERATE switch S28 must be placed in the OFF position before the fault can be corrected or the fault circuit reset. After the fault has been corrected, SAFETY RESET switch S9 on the control panel is depressed, extinguishing the LOW LUBE OIL PRESS indicator lamp and resetting the fault circuit to its original state. If emergency operation is necessary, SAFETY BYP switch S5 is placed to the EMER OPER ONLY position, deenergizing relay K4 and allowing continued engine-generator set operation. If the engine-generator set is being operated from a remote transfer panel, the safety reset and safety bypass functions can also be accomplished by appropriate switches.

1-60. During the initial starting period, before normal oil pressure is reached, the oil pressure will be below 10 psi and, as a result, the low lube oil pressure switch will be closed. This would normally activate the low lubricating oil pressure fault circuit and causes the LOW LUBE OIL PRESS indicator lamp to light. This is prevented, however, by the action of 10 second delay engine run relay K3 which controls the activation of the fault circuits. Since the relay requires 10 seconds to conduct after the engine has started, the lubricating oil should, within this interval, have sufficient time to build up to normal operating pressure.

1-61. ENGINE OVERSPEED FAULT CIRCUIT. (See figure 1-12.) During normal operation of the engine-generator set, engine speed will normally be 1800 rpm at 60 Hz and 1500 rpm at 50 Hz. To protect the engine against an overspeed condition during both modes of operation, overspeed switch S7 is provided to actuate at a predetermined speed between the range of 2070 and 2250 rpm. If, during engine-generator set operation, an engine overspeed condition occurs, overspeed switch S7 closes and applies 24 volts dc energizing voltage to the coil of overspeed fault relay K8. This causes normally open A and B contacts of the relay to close, energizing and locking relay K8 in the same manner as the fault relay previously described. Relay K4 is energized and operates to shut down the engine and inhibit the generator load contactor circuits. Relay K6 is also deenergized at this time to inhibit the load contactor circuits. The fault is indicated by the lighting of OVER SPEED indicator lamp DS2 located on the control panel, with the lamp remaining illuminated after the engine-generator set has shut down. The remote overspeed and engine fault indicator lamps will also light, if connected. Resetting of the overspeed fault circuits or possible continued emergency operation can be accomplished by the SAFETY RESET or SAFETY BYP switches, as previously described.

1-62. HIGH COOLANT TEMPERATURE FAULT CIRCUITS. (See figure 1-12.) Under normal operating conditions, and depending upon the load, the operating temperature range of the engine coolant is between 74°C (165°F) and 85°C (185°F). If coolant temperature exceeds 102°C (217° ±5°F), high coolant temperature thermal switch S6 closes and applies a ground return to the coil of high coolant temperature fault relay K7. The relay then energizes and locks by a ground return applied through its operated A contacts. The ground return is also applied to COOLANT TEMP HIGH indicator lamp DS1 located on the control panel, and to the remote high coolant temperature and engine fault indicator lamps, if connected. Master engine fault lockout relay K4 is also energized at this time through operated B contacts of relay K7 and operates in the same manner as previously described to shut down the engine and disconnect the generator from the load. Engine operating relay K6 is also deenergized to disconnect the generator from the load. After the fault is corrected, the COOLANT TEMP HIGH indicator lamp is extinghished and the fault circuit reset to its original state by operation of the SAFETY RESET pushbutton. For continued emergency operation, the high coolant temperature fault can be bypassed by operation of the SAFETY BYP switch.

1-63. LOW FUEL PRESSURE FAULT CIRCUIT. (See figure 1-12.) During normal operation of the engine-generator set, fuel pressure will be 120 psi, or above, and normally closed fuel pressure fault switch S17 will be open. If the fuel pressure falls below 35 ±5 psi, the fuel pressure switch closes and applies 24 volts dc to the coil of master engine fault lockout relay K4. This relay, and relay K6, then operate as previously described to shut down the engine and disconnect the generator from the load. In this instance, however, no fault indicator lamp will light on the control panel to indicate the malfunction although the remote engine fault indicator lamp will light, if connected.

1-64. Since the energization of relay K4, through the engine fuel pressure switch, is controlled by 10 second delay engine run relay K3, the fuel pressure is allowed to reach its normal operating pressure during the initial starting and running period. This permits the fuel pressure switch to open during this 10-second period and is, in this respect, similar to the operation of the low lubricating oil pressure fault circuit. Blocking diode CR4 is connected in series with the fuel pressure switch to prevent the energizing and locking up of relay K6 through the fuel pressure switch and operated B contacts of relay K4. If relay K6 were to be locked up in this manner, its operated B contacts would still apply voltage to voltage frequency monitor

K13 (figure 1-14) causing the subassembly to sense a false undervolt condition. In the event that an electrical fault had occurred, however, relay K3 would be cut off and could not supply energization voltage for K4 through CR4. An alternate path, through CR6, is provided to permit the sensing of a low fuel pressure fault during a concurrent electrical fault.

1-65. GENERATOR FAULT CIRCUITS.

1-66. GENERAL. To protect the generator from damage, the engine-generator set is equipped with safety devices to automatically remove exciter-generator field excitation and disconnect the generator from the load if one or more of the following faults exist: overvoltage, undervoltage, overcurrent, under frequency, and short circuit. An appropriate red warning indicator lamp on the control panel lights to indicate the area of malfunction and remains illuminated after the generator has been disconnected from the load. The light can then be extinguished by depressing the SAFETY RESET pushbutton after the malfunction has been corrected. The engine will continue to run during a generator fault condition.

1-67. OVERVOLTAGE AND UNDERVOLTAGE FAULT CIRCUITS. (See figure 1-13.) Monitoring of overvoltage and undervoltage generator faults is accomplished by voltage frequency monitor K13 located in the control box assembly. Sensing circuits for the voltage and frequency monitor are self-contained, with the exception of the overcurrent section, whose sensing is accomplished by external circuitry. The overcurrent section is for indication purposes only.

1-68. Voltages from generator G1 are applied to K13 at pins 1, 2, and 3, and 24 volts dc is applied to pins 4 and 5. The overvoltage section is calibrated to trip between 130 and 135 volts ac for 50 Hz operation, and between 145 and 150 volts ac for 60 Hz opertion. If an overvoltage condition occurs for two seconds in one of the monitored phases, the 24 volts dc from SAFETY RESET switch S9 which is applied to K13 pin 14 is fed through pin 15 to the coil of exciter field control relay K9 and to generator fault lockout relay K23. When K9 energizes, its A contacts open, removing the d-c voltage from K13 pins 4 and 6. Its C contacts also open, removing the field excitation from the exciter-generator. In addition, the B contacts or relay K9 close, providing a holding circuit for K9 for that the exciter-generator field excitation is inhibited. The conducting or relay K23 causes 24 volts dc to be removed from the coil of engine operating relay K6, thereby disconnecting the generator from the load. 24 volts dc is also applied to OVERVOLT indicator lamp DS6 on the control panel to indicate the fault, and to the remote overvolt indicator lamp, if connected.

1-69. After the fault has been corrected, SAFETY RESET switch S9 is depressed, extinguishing the OVER VOLT indicator lamp and resetting the overvoltage fault circuit to its original state. If emergency operation is necessary, SAFETY BYP switch S5 is placed in the EMER OPER ONLY position, cutting off relay K23.

1-70. If, during normal operation of the engine-generator set, an undervoltage condition occurs for eight seconds (between 94.5 and 99 volts ac for 50 Hz operation, and between 105 and 110 volts ac for 60 Hz operation), the condition is again sensed by voltage frequency monitor K13. The 24 volts dc from switch S9 which is applied to K13 pin 9 is fed through pin 10 to relays K9 and K23. These relays then operate as described in paragraph 1-68 to inhibit the field excitation of the exciter-generator and to disconnect the generator from the load. Resetting of the undervoltage fault circuit after the trouble has been corrected, or possible emergency operation, is accomplished by the SAFETY RESET or SAFETY BYP switches, as previously described.

1-71. If a low lube oil pressure fault occurs, causing the engine to shut down and the generator voltage to decrease to zero, a false undervoltage condition could possibly occur. This condition would remain after engine shut down due to operation of the undervoltage lock-up circuit. Normally closed C contacts of low lube oil pressure fault relay K18 are provided to prevent this false undervoltage condition. When a low lube oil pressure fault occurs, relay K18 energizes, and the opening of its C contacts inhibit the lock-up voltage to the undervoltage fault circuit. An undervoltage condition would also normally be indicated ten seconds after the engine-generator set has been put into operation. This is because the undervoltage fault circuits are activated as a result of 10 second delay engine run relay K3 conducting. This is prevented, however, during the starting procedure, by the setting of SAFETY BYP switch S5 to the EMER OPER ONLY position, which prevents the energizing of the fault circuits.

1-72. When the engine-generator set is operating in the 60-Hz mode, the full phase-to-neutral excitation is applied to the coils of overvoltage and undervoltage monitoring elements A, B, and C. At this time, FREQ SEL switch S30 will be in the 60 Hz position, and the switch will have no effect on the operation of the relays. When the switch is in the 50 HZ position, less then full excitation voltage is generated by generator G1, and consequently, less voltage is required to activate the overvoltage and undervoltage relays. This reduced relay energizing voltage is supplied by switch S30 which applies the neutral return of the generator to the elements through the preadjusted taps of the elements to activate the relays at the lowered excitation voltage.

1-73. OVERCURRENT FAULT CIRCUITS. (See figure 1-14).) Monitoring of overcurrent generator faults is accomplished by current transformers T1, T2, and T3, which monitor phase currents from generator terminals T7, T8, and T9, respectively. If generator G1 produces an overcurrent condition in one or more of the three phases, the condition is sensed by the appropriate current transformer and transmitted to kilowatt transducer D1. The kilowatt transducer is a sealed, solid state unit which measures the power output of the generator to an accuracy of 3 percent from no-load to rated full-load current. The input voltage (from the current transformers) is stepped down, rectified, filtered, and applied to the internal sensors of the transducer. The output of the sensors is applied to wattmeter M5 on the control panel. From the transducer, the sensor outputs are also applied to appropriate short circuit fault relays K10, K26, or K27, and OVERLOAD RESET pushbutton relays K20A, K20B, or K20C, which are in series with relays K10, K26, and K27, respectively.

1-74. If the overcurrent condition is due to a short circuit, appropriate fault relay K10, K26, or K27 immediately energizes, as does OVERLOAD RESET relay K20A, K20B, or K20C. When the overcurrent condition is in excess of 125 percent of rated current, appropriate OVERLOAD RESET relay K20 energizes within five seconds, as does the appropriate fault relay. When an OVERLOAD RESET relay energizes, its pushbutton contacts open, disconnecting the exciter-generator field excitation.

1-75. When a short circuit fault relay becomes energized, 24 volts dc from the SAFETY RESET switch is applied through operated contacts of the energized fault relay to exciter field control relay K9 and generator fault lockout relay K23. These relays then operate as previously described in the overvoltage and undervoltage fault circuits to inhibit exciter-generator field excitation and to disconnect the generator from the load. The 24 volts dc from the fault relay is also applied through operated B contacts or relay K9 to voltage frequency monitor K13. From K13, the d-c voltage is applied to OVER CURRENT indicator lamp DS3 on the control panel and to the remote over current indicator lamp, if connected. The lamps continue to indicate the

fault until the trouble has been remedied. Resetting of the overcurrent fault circuit after the trouble has been corrected is accomplished by depressing both SAFETY RESET pushbutton S9 and OVERLOAD RESET pushbutton K20 on the control panel.

1-76. AM-VM SEL SW. The output voltage and current of phases 1, 2, and 3 of generator G1 is monitored by a-c voltmeter M6 and a-c ammeter M7 located on the control panel. Selection of the desired phase is accomplished by AM-VM SEL SW S24, also located on the control panel, which has four positions, L1-L2 PH1, L2-L3 PH2, L3-L1 PH3, and L3-L0 OFF. In each switch position, a return path is always present for the operation of OVERLOAD RESET pushbutton relay K20A, K20B, and K20C, and short circuit fault relays K10, K26, and K27. Refer to table 1-2 for the function of switch S24 for each of its four positions.

1-77. BATTERY CHARGING CIRCUIT. (See figure 1-15.)

1-78. Prior to starting the engine, the battery charging system is preset by depressing BAT CHGR CKT BKR (CB1) on the control panel. After the engine is started and is running for ten seconds, 10 second delay engine run relay K3 conducts and applies 24 volts dc to the coil of engine run slave relay K24, energizing the relay. This permits 120 volts ac from generator G1 terminals T8 and T11 to be applied through operated B and C contacts of relay K24 and BAT CHGR switch S19 to the primary of battery charging transformer T6. Switch S19 controls the rate of charge of batteries BT1 and BT2.

1-79. When switch S19 is in the HIGH position, 3 to 5 amperes are supplied to the battery. When switch S19 is in the LOW position, a trickle charge is supplied to the battery at a rate that will not damage the battery or evaporate an appreciable amount of electrolyte from the battery when it is subjected to continual and prolonged operation. Setting switch S19 to the OFF position disconnects the battery charging circuit. Depending upon the position of the BAT CHGR switch, the a-c voltage is applied through high or low rate battery charging variable resistors R3 or R2, which are adjusted to regulate the rate of battery charging current. From the variable resistors, the 120 volts ac is applied to an a-c power supply circuit composed of battery charging step-down transformer T6 and full-wave rectifier CR1. The d-c output of the rectifier is then applied through battery charging ammeter M4 and DC SYS CKT BKR CB3 to batteries BT1 and BT2.

1-80. Provision is made for recharging the batteries during non-operating periods of the engine-generator set if external 120-volt a-c power is available. This is accomplished by connecting the a-c external source between terminal boards TB2-10 and TB2-11. With the BAT CHGR switch in the HIGH position and the BAT CHGR CKT BKR depressed, charging current is applied to the batteries through normally closed A and D contacts of relay K24. In the event an external d-c source is to be used for charging the batteries, receptacle J6, located on the left side of the skid, is provided. The POWER RECEPTACLE 28 VDC STARTING receptacle can also be used for starting the engine-generator set if batteries BT1 and BT2 are weak, or have been removed. If, after the engine-generator set has been started, the batteries or external starting source have to be removed, satisfactory operation of the unit can still continue if the BAT CHGR switch is set to the HIGH position. This permits sufficient power, 3 to 5 amperes, to be supplied by the battery charging circuit to the engine-generator control circuits.

1-81. ELECTRIC HEATER OPERATION. (See figure 1-15.)

1-82. When 120 volt a-c external power is available, electric heaters are used to maintain suitable starting temperature for the engine lubricating oil and coolant, and for the battery box, without the use of starting aids. After the engine-generator set is in operation and the external a-c source has been disconnected, only the battery box heaters can be kept in operation.

1-83. Electric heater operation is initiated when the external 120 volt a-c source is connected between terminal boards TB2-10 and TB2-11, and ELEC HTR switch S18 on the control panel is set to the ON position. The a-c voltage is then applied through contacts of switch S18-1 and normally closed thermal switch S21 to lubricating oil and coolant immersion heaters HR1 and HR2. For heating of the battery box, the a-c voltage is applied through normally closed A and D contacts of deenergized relay K24 to contacts of switch S18-2. The a-c voltage is then applied through normally closed thermal switch S22 to battery box strip heaters HR4 and HR5. When the ambient temperature of the lubricating oil, coolant, and battery box reaches 43°C (110° ±5°F), the two thermal switches open, deenergizing the heaters. The thermal switches will automatically close when the ambient temperature drops to 5°C (40° ±5°F), causing the heaters to again cycle on. The temperatures for the lubricating oil, coolant, and battery box are thus maintained between these limits. After the engine is in operation, battery box temperature can still be maintained since the battery box heaters remain energized by the 120 volts a-c generator voltage applied to the heaters through operated B and C contacts of energized relay K24. The lubricating oil and coolant immersion heaters, however, cannot be kept operating once the engine-generator set is in operation and the 120-volt, a-c power source is removed.

1-84. ENGINE SPEED CONTROL CIRCUIT. (See figure 1-15.)

1-85. The frequency generated by the engine-generator set is determined by the speed of the engine, and the speed of the engine is controlled by the electric governor system. The magnetic pickup EG1-P is located near the engine flywheel, so that, as it revolves, each tooth on the flywheel ring gear penetrates the magnetic field of the pickup. An a-c signal is generated, the frequency of which is proportional to engine speed. This signal is fed to the control unit EG1-C where it is compared to the preset governor system control frequency. The control unit compensates for any difference in frequency by adjusting the d-c current applied to the actuator assembly EG1-A. This d-c current controls the position of the actuator arm assembly, which positions the throttle valve metering valve to maintain constant speed. The actuator assembly also contains a hydraulically balanced fuel metering valve assembly to ensure quick engine response to load changes. FREQ ADJ potentiometer R18 provides a means of adjusting the resultant frequency from the control panel. FREQ SEL switch S30 permits selection of 50-Hz or 60-Hz mode of operation. OPERATION switch S20 permits selection of single unit or parallel operation of the engine-generator set.

1-86. PANEL AND TROUBLE LIGHT CIRCUITS. (See figure 1-15.)

1-87. Operation of the panel lights is initiated by the PANEL LIGHTS switch S10 on the control panel. When set to the ON position, 24 volts dc is applied to panel lights DS7 and DS8 on the control panel. If the use of a trouble light is required, a trouble light receptacle, J3, nomenclated TROUBLE LT RECP 24 V.D.C., is located on the control panel. In order for the trouble light to be used, D.C. SYS CKT BKR CB3 and TROUBLE LT CKT BKR CB2 on the control panel must first be depressed, allowing 24 volts dc to be applied to the receptacle.

1-88. GENERATOR AND EXCITER-GENERATOR CONTROL CIRCUITS.

1-89. MANUAL VOLTAGE REGULATION. (See figure 1-16.) During the starting cycle of the engine-generator set, field flashing relay K29 is energized (refer to paragraph 1-52), closing normally open contacts C and D. This action applies 24 volts dc across the exciter field of exciter-generator G2, thereby eliminating dependence upon residual magnetism for starting. When the engine-generator set has started, relay K29 is deenergized (by

tion of speed sensing switch S11, and contacts A and B of K29 e, connecting the exciter field of G2 to the regulation circuits. back diode CR5 is provided to keep current flowing in the field during the negative half cycle. After the engine-generator set has been started, voltage regulation of generator G1 can be accomplished either manually or automatically. If manual ulation is desired, VOLTAGE REGULATION switch S29 on the ol panel is set to the MAN position and VOLT FREQ TROL SW S12 is set to the LOCAL position. The generator ge is then raised to the required level by the operation of VOLTAGE REGULATION-MANUAL transformer T7 located on the control panel. Variable transformer T7 receives 120 volt a-c excitation (phase-to-neutral) from generator G1. A portion of the a-c excitation is applied to the wiper arm of the transformer with the amount of excitation increasing as the transformer control knob is rotated in the RAISE direction. From the wiper arm of the transformer, the a-c pick-off voltage is applied to transformer T1 in transformer-rectifier subassembly A1 located on the control box assembly. On positive-half cycles the a-c excitation voltage is applied from a tap of transformer T1 through diode CR9 to the MAN position of the VOLTAGE REGULATOR switch S29. From the switch, the rectified voltage is applied through normally closed overload reset switch K20, normally closed C contacts of exciter field control relay K9, and normally closed contacts of field flashing relay K29 to the exciter field. On negative half cycles, field current for the exciter-generator flows through diode CR2. Transformer T1 thus acts to reduce the rectified d-c voltage to an average value necessary to provide the specified range or operation. Operation of the VOLTAGE REGULATION-MANUAL control will then control exciter field excitation about this average level. The a-c excitation generated by the exciter-generator is rectified by rectifier assembly CR3 and applied to the field of generator G1. Thyrite components A1 and A2 in the rectifier assembly serve as surge resistors to limit the initial surge current through the generator field.

If a generator fault occurs, exciter field control relay K9 , energize, its C contacts will open, and the exciter field will be deenergized. The field is also disconnected when OVERLOAD RESET pushbutton K20 opens. For emergency operation, the field can be excited before the fault has been corrected by placing SAFETY BYP switch S5 to the EMER OPER ONLY position. This closes contacts S5-2 which reconnects the exciter field circuit by bypassing the open contacts of relay K9 and OVERLOAD RESET pushbutton K20.

1-91. AUTOMATIC VOLTAGE REGULATION. When automatic voltage regulation is desired, the VOLTAGE REGULATION switch S29 is set to the AUTO position and the generator voltage is raised to the required level by operation of VOLTAGE REGULATION-AUTOMATIC rheostat control R13. After the voltage is adjusted, voltage regulator subassembly VR1 in the control box assembly operates to automatically maintain this voltage for various changes of load conditions.

1-92. During remote operation of engine-generator set, voltage regulation is also performed automatically. When remote operation is desired, the VOLTAGE REGULATION-AUTOMATIC control serves as a coarse regulation adjustment which is first adjusted for approximately 205 volts ac (120/208-volt operation). Voltage regulation is then switched to remote control by setting VOLT FREQ CONTROL SW S12 to the REMOTE position. This causes make-before-break contacts S12-2 to connect a remote ge regulation-automatic control into the automatic regulating it. This becomes a fine adjustment for raising the generator ge to the required level. Voltage regulation will then be maintained automatically by VR1. The make-before-break contacts of S12-2 are required to prevent momentarily disconnecting the automatic voltage regulating circuit during the switchover m LOCAL to REMOTE while the engine-generator set is in ation. If the regulating circuit were to be interrupted for this instant, automatic voltage regulation would be lost and an overvoltage condition would occur. For automatic voltage regulation during 50-Hz or 60-Hz operation, FREQ SEL switch S30 is provided. When set to either position, contacts S30-2 apply a-c excitation from cross current transformer T4 to the sensing network VR1 that permits automatic voltage regulation in either operating mode. (Refer to paragraph 1-93 for the operation of voltage regulator subassembly VR1.) If VR1 should fail during automatic voltage regulation, manual control can be maintained by placing VOLTAGE REGULATION switch S29 to the MAN position.

1-93. VOLTAGE REGULATOR SUBASSEMBLY VR1.

1-94. GENERAL. Voltage regulator subassembly VR1 is provided to maintain automatic voltage regulation of the generator after the generator voltage has been adjusted to the required amount. This regulation maintains the output voltage constant (±1%) by controlling the field current, and hence the output voltage, of the alternator. The voltage regulator subassembly consists of the following circuits: detector circuit and rectifier, silicon controlled rectifier trigger module, silicon controlled rectifier output, adjustable stabilizing (anti-hunt) network, and regulation compensation circuit.

1-95. As the exciter field voltage builds up (during initial start-up of the generator) and the alternator output reaches a preselected magnitude, a relay is energized connecting the silicon controlled rectifier into the circuit. As the output voltage varies, an * [illegible] and polarity are proportional to the error) appears [illegible] module. The output of the trigger module will vary the conduction period of the silicon controlled rectifier which, in turn, controls the exciter field current, and thus alters the output voltage.

1-96. The high gain of the regulator requires that a stabilizing circuit be included. This circuit controls the damping of the closed loop system so that close regulation can be obtained without oscillation. The stabilizing circuit measure the rate of change of the output of the regulator, and feeds it back to the control terminals of the trigger module. The voltage compensating adjustment provides for precise setting of the output voltage from no load to full load, independent of changes in voltage waveform.

1-97. RECONNECTION PANEL AND SYNCHRONIZING CIRCUITS. (See figure 1-17.)

1-98. During engine-generator set operation, 120 volts ac is applied from G1, through transformer T8 to diode CR2. 24 volts dc from CR2 is applied to LOAD CONTRACTOR switch S16 on the control panel. When the switch is set to the ON position, the d-c voltage is applied through normally closed C contacts of engine fault lockout relay K4 to normally open C contacts of engine operating relay K6. Ten seconds after the engine-generator set is started, relay K6 energizes, causing the d-c voltage to be applied through the C contacts or relay K6 to the coil of generator load contactor relays K19A and K19B. When relay K19A energizes, the generator output is fed to servant posts T1, T2, and T3; L1P, L2P, and L3P; and L1, L2, and L3. When relay K19B energizes, the generator output at servant posts T7, T8, and T9, is fed to servant post T7, T8, and T9. The neutral output of the generator is connected directly to servant posts LOP and LO.

1-99. When generator voltage is tranferred to the reconnection panel, LOAD TERM ENERGIZED indicator lamp DS10 on the control panel lights to indicate that the reconnection panel is

*An error signal (whose amplitude and polarity are proportioned to the error) appears across the sensing terminals of the trigger

energized and that the load can be connected to the appropriate servant posts. When the engine-generator set is connected to produce 120/208 volts excitation, the positioning of the links on the reconnection panel cause 120/208 VOLT CONN indicator lamp DS13 on the control panel to light. Similarly, when the links are positioned to produce 240/416 volts excitation, 240/416 VOLT CONN indicator lamp DS14 on the control panel lights. (Refer to the reconnection panel setup diagram shown in figure 4-2 for the positioning of the links in each mode of operation.) Zener diode CR7 limits the voltage applied to either DS13 or DS14. Load contactor relays K19A and K19B are deenergized by the opening of C contacts of relay K4 when relay K4 is energized (engine fault), and by the opening of C contacts of relay K6 when relay K6 is deenergized (engine or generator fault).

1-100. When two or more engine-generator sets are to be operated in parallel, OPERATION switch S20 on the control panel is placed from the SINGLE UNIT position to the PARALLEL position. This causes phase-to-phase excitation (208 or 416 volts ac) from reconnection panel terminals T1 and T3 to be applied through contact S20-1 and S20-2 to SYNCHRONIZING indicator lamps DS11 and DS12 on the control panel. The lamps are used to guide the operator in the synchronizing of the parallel units by blinking when the units are not synchronized and by extinguishing when the units are synchronized. The operation of switch S20 to the PARALLEL position also causes normally closed contacts S20-3 to open, connecting current adjust potentiometer R14 in parallel with cross current transformer T4. Potentiometer R14 is preadjusted for the correct generator voltage to permit proper parallel operation.

TABLE 1-2. AM-VM SEL SW S24 FUNCTION

AM-VM SEL SW S24 Position	Current Monitoring (M6)	Voltage Monitoring (M7)	A-C Voltage Readings	
			60 Hz Operation	50 Hz Operation
L1-L2 PH1	Phase 1	Between phase 1 (L1) and phase 1 (L2)	208 or 416	190 or 380
L2-L3 PH2	Phase 2	Between phase 2 (L2) and phase 3 (L3)	208 or 416	190 or 380
L3-L1 PH3	Phase 3	Between phase 1 (L1) and phase 3 (L3)	108 or 416	190 or 380
L3-L0 OFF	None	Between phase 3 (L3) and neutral (L0)	120 or 240	110 or 220

Charts Transposed to

End of Volume.

SECTION II

SPECIAL SERVICE TOOLS

No special service tools are required.

SECTION III

PREPARATION FOR USE, STORAGE, OR SHIPMENT

3-1. PREPARATION FOR USE.

3-2. UNCRATING. The engine-generator set is packaged and crated for shipment in accordance with MIL-P-116 and MIL-C-132, respectively. To uncrate the engine-generator set, proceed as follows:

CAUTION

Exercise care in uncrating the engine-generator set to avoid damage to components or instruments. Never allow tools used in unfastening tie-down or bracing supports to fall or slip into the equipment.

a. Remove double-layered barrier bag, taking care not to destroy it.

NOTE

The barrier bag and all other packaging material may have to be reused. Where possible, they should be stored for possible reuse.

b. Remove sway bracings.

c. **Deleted**

d. Remove and unpack single package (packaged in accordance with MIL-P-207A) which contains 32.8 quarts of storage battery electrolyte.

WARNING

Wear safety goggles and gloves whenever it becomes necessary to handle storage battery electrolyte.

3-3. UNLOADING AND INSTALLATION

PARAGRAPHS a through h are DELETED.

i. Store all packaging and uncrating materials which are in good condition for possible reuse.

j. When engine-generator set is installed on soft ground, use boards, planks, or legs to make it as level as possible.

CAUTION

Never operate the engine-generator set at an angle greater then 15° from the horizontal.

k. If engine-generator set is located in an enclosed area, be certain there is adequate ventilation to carry off escaping exhaust gasses and to provide sufficient intake air for diesel engine. Locate the engine-generator set so that exhaust gases may be carried to outside with a minimum number of bends in exhaust line. All exhaust connections must be gas-tight. Provide at least two feet of space on all sides of the unit. Make certain there is sufficient air circulation for proper engine operation.

WARNING

Do not operate engine-generator set in an enclosed area unless the exhaust gases are piped to the outside.

NOTE

Refer to figure 3-1 for installation dimensions and particulars.

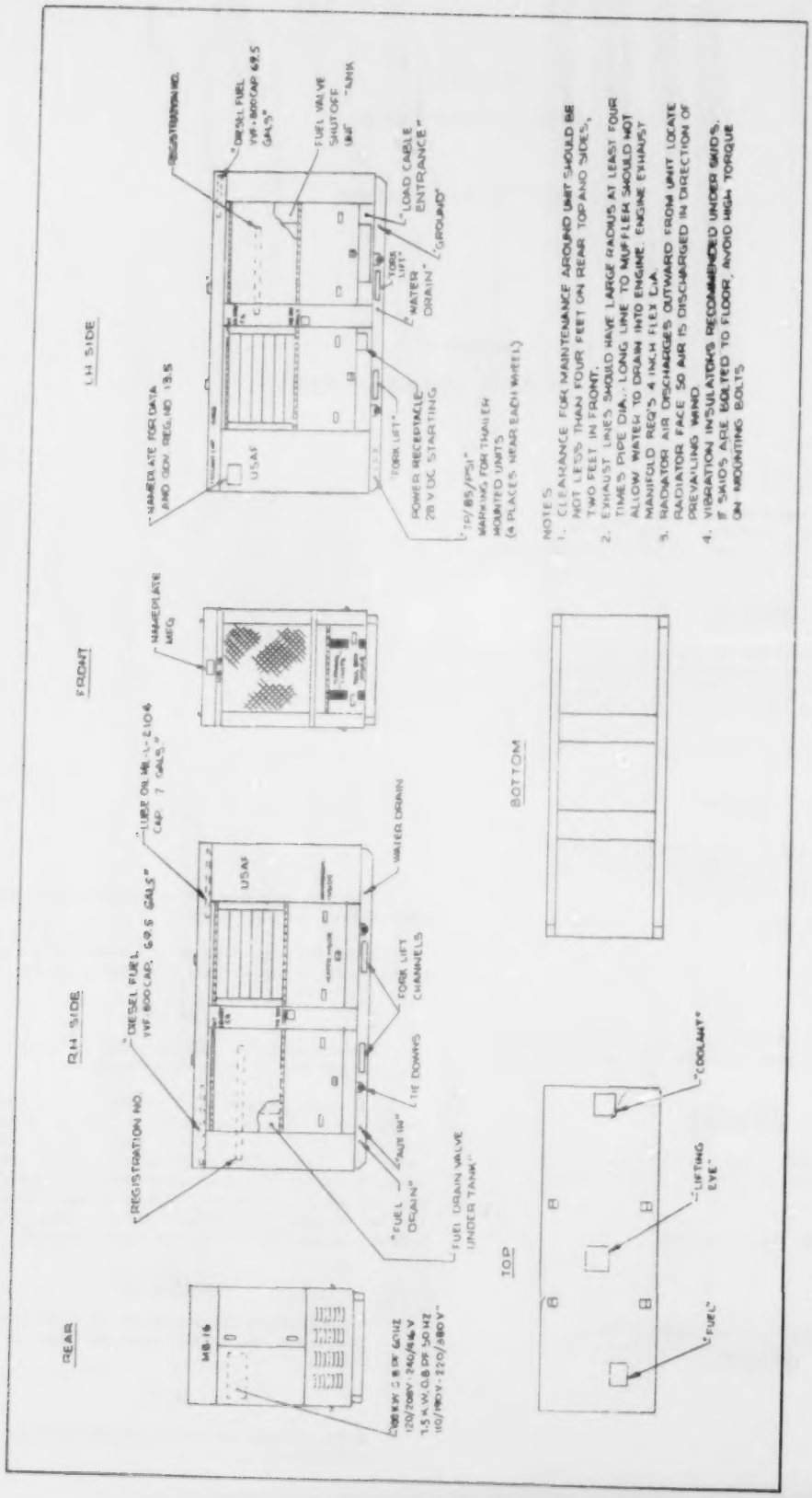

REAR
RH SIDE
FRONT
LH SIDE
TOP
BOTTOM
NOTES
1. CLEARANCE FOR MAINTENANCE AROUND UNIT SHOULD BE NOT LESS THAN FOUR FEET ON REAR TOP AND SIDES, TWO FEET IN FRONT.
2. EXHAUST LINES SHOULD HAVE LARGE RADIUS AT LEAST FOUR TIMES PIPE DIA. LONG LINE TO MUFFLER SHOULD NOT ALLOW WATER TO DRAIN INTO ENGINE. ENGINE EXHAUST MANIFOLD REQ'S 4 INCH FLEX LIA.
3. RADIATOR AIR DISCHARGES OUTWARD FROM UNIT LOCATE RADIATOR FACE 50 AIR IS DISCHARGED IN DIRECTION OF PREVAILING WIND.
4. VIBRATION INSULATORS RECOMMENDED UNDER SKIDS. IF SAIOS ARE BOLTED TO FLOOR, AVOID HIGH TORQUE ON MOUNTING BOLTS

Figure 3-1. Installation Drawing

l. Check that rain cap at exhaust opening moves freely.

m. Attach one end of a No. 6 AWG solid wire to the GROUND terminal at the rear portion of the left skid and the other end to a ground electrode such as underground water piping system or a ground rod.

3-4 UNLOADING AND INSTALLATION

To unload skid-mounted engine-generator set from wooden shipping skid and install after removal, proceed as follows:

a. Connect cable hook of crane capable of lifting the engine-generator set to the lifting eye of engine-generator set.

b. Lift engine-generator set off wooden shipping skid and place at desired area.

c. Refer to paragraph 3-3 steps i through m, and proceed with installation procedures.

3-5. PRELIMINARY INSPECTION. The following items should be inspected:

a. Check engine-generator set components and accessories against shipping list.

b. Visually inspect all components and accessories for possible damage incurred during shipping or storage.

NOTE

If any damage is noted, or the components and/or accessories do not check with the shipping list, report the discrepancy to the cognizant authority in accordance with existing directives.

c. Inspect engine-generator set for loosely mounted components.

d. Inspect wiring for cuts and loose connections.

3-6. DELETED

3-7. PREPARING ENGINE CRANKCASE FOR USE. To prepare engine crankcase for use, proceed as follows:

a. Open lubricating OIL DRAIN valve at center portion of left skid and allow crankcase oil to drain into suitable container.

b. Close OIL DRAIN valve.

c. Remove lubricating oil filler cap and fill crankcase with 9 gallons of lubricating oil in accordance with MIL-L-2104.

d. Replace lubricating oil filler cap.

e. Check lubricating oil level in crankcase with dipstick gage. Wipe dipstick with cleaning cloth and reinsert into crankcase. Remove dipstick gage and hold over cleaning cloth to catch oil dripping from dipstick gage. Dipstick gage should be covered with oil up to FULL mark. If not repeat steps c through e until crankcase is filled to 7 gallon capacity level.

f. Replace dipstick gage.

3-8. PREPARING ENGINE AIR CLEANER FOR USE. To prepare engine air cleaner for use, proceed as follows:

a. Carefully remove oil pan from bottom of engine air cleaner by loosening two wing nuts at side of pan.

b. Clean inside of oil pan if required.

c. Fill oil pan with 1 gallon of lubricating oil such as that used in crankcase.

d. Carefully return oil pan to bottom of air cleaner and lock in place by tightening wing nuts.

3-9. PREPARING COOLANT SYSTEM FOR USE. To prepare coolant system for use, proceed as follows:

a. Check that WATER DRAIN valve at front portion of right side is closed.

b. Remove radiator filler cap. (Access to filler cap is through COOLANT [illegible] portion of housing roof.)

c. Fill coolant system, through open radiator port, with water and ethylene glycol as indicated in table 3-1 to within two inches of overflow pipe. Table 3-1 indicates the quantity of antifreeze solution to be added to the system for lowest expected temperature.

CAUTION

Quantities given in table 3-1 are expressed in terms of pints of antifreeze to each gallon of coolant, not pints of antifreeze added to each gallon of water.

NOTE

If moderately soft water is not obtainable, it is recommended that coolant system be drained semi-weekly and flushed with clear running water. One pound of soda ash, Federal Specification O-S-571, may be added to the water to soften it and retard formation of coatings on inside of water jacket and radiator core. When using ethylene glycol, Federal Specification O-E-771, as a freezing deterrent, it is advisable to add a high quality corrosion inhibitor to coolant, preferably one recommended by manufacturer of ethylene glycol.

d. Replace radiator filler cap.

e. Check radiator, hoses and all fittings for leakage. Remove and replace, or repair defective parts (refer to Section VI).

3-10. PREPARING FUEL SYSTEM FOR USE. To prepare fuel system for use, proceed as follows:

a. Set FUEL VALVE SHUT OFF (located beneath set fuel tank) to OFF position.

* lid at front portion of housing roof).

b. Set FUEL DRAIN VALVE (located beneath set fuel tank) to OFF position.

c. Remove tape from fuel tank openings, and fuel inlet and outlet openings.

d. Lift FUEL access lid at rear portion of housing roof and remove set fuel tank filler cap.

e. Fill set fuel tank with JP-4 fuel, Specification MIL-F-5624, or diesel fuel of proper grade, Specification VV-F-800 to its capacity of 69.5 gallons.

WARNING

Do not manually refuel the engine-generator set with the engine running or hot because of possible danger to personnel and damage to equipment. Make certain that the engine-generator set is properly grounded before refueling.

f. Replace filler cap and close FUEL access lid.

CAUTION

Do not use winterization system heater air valve for replenishing engine oil supply. The oil does not drain rapidly enough into the crankcase resulting in oil backing up into the heater assembly, rendering the heater system inoperative.

g. Prior to use of auxiliary fuel source, examine if fuel source is above or below ground level. If above ground level follow step 1. If below ground level follow step 2.

1. If the auxiliary fuel source is located above the unit set tank, an electric solenoid valve 24 VDC NC must be installed between the auxiliary source and the electric fuel pumps to prevent syphoning. Connect 24 volt coil in parallel with electric fuel pumps B4 and B5. These are powered by K31 terminal point #5. Therefore we suggest the additional solenoid be connected at same power source. (Solenoid is G.F.E. (Government Furnished Equipment)).

WARNING

As the fuel injection pump requires a return flow back to tank it must never be restricted or plugged. Such action will raise internal pressure and resultant seal failures and/or leakage will be experienced.

2. Should the external source be more than 20 feet away from generator set and/or buried said application could very well necessitate the implementation of another electric motor driven auxiliary fuel transfer pump to lift fuel from storage tank to generator set.

3-11. PREPARING BATTERIES FOR USE. To prepare batteries for use, proceed as follows:

a. Remove sides and top of battery box.

b. Remove batteries from engine-generator set and place on level surface.

c. Remove battery caps.

WARNING

Wear safety goggles and gloves whenever handling electrolyte. Exercise extreme care to avoid spilling electrolyte on clothing or skin Should electrolyte come in contact with skin, wash the affected area immediately with liberal amounts of water and then a mild alkaline solution, such as sodium bicarbonate or soapy water.

d. Pour electrolyte carefully from original container into pouring vessel made of glass, china, earthenware, or rubber. Do not use metal container.

e. Fill each battery cell with electrolyte (shipped with generator set) to mark over plates. Using a hydrometer, check the specific gravity of each cell. The specific gravity of each cell should read 1.280 ±0.005 at 25°C (77°F).

f. Replace battery caps and remove tape from each cap vent.

g. Clean preservative compound from battery terminals with solvent, Federal Specification P-S-661.

h. Check batteries for leaks or cracks.

i. Install batteries in battery box, with terminals positioned as shown in figure 3-2, and clamp down in place.

j. Remove tape securing battery cables to battery carrier.

k. Remove wrapping material from cables.

l. Install battery cables (see figure 3-2), making connections as shown.

m. Return cover and side of battery box.

3-12. PRE-OPERATIVE CHECK. Prior to each operation of the engine-generator set, check the following.

a. Check that lubricating oil level is at FULL mark on dipstick gage. If necessary, add lubricating oil (refer to paragraph 3-7).

b. Check that engine coolant is within two inches of overflow. If necessary, add coolant (refer to paragraph 3-9).

c. Check that drive belts at front of engine-generator set are properly adjusted. If necessary, adjust cam nut for proper belt tension.

d. Check that WATER DRAIN and FUEL DRAIN SHUT OFF valves are in closed position.

e. Check that fuel quantity as indicated by fuel level gage on control box is sufficient for intended operation. If necessary, add fuel oil (refer to paragraph 3-10).

f. Drain some fuel through DRAIN VALVE AND PLUG of set tank and check for water accumulation.

g. Check that battery electrolyte level is above battery plates. Add electrolyte (refer to paragraph 3-11).

h. Close all large access doors.

i. Check that the fuel burning heater strainer valve is open.

3-13. DELETED

TABLE 3-1. ENGINE-GENERATOR SET COOLANT REQUIREMENTS

Lowest Expected Temperature (°F)	Pints of Ethylene Glycol per Gallon of Coolant	Arctic Antifreeze Compound (MIL-C-11755A)	Pints of Denatured Alcohol (grade III emergency) Antifreeze Solution per Gallon of Coolant	Specific Gravity 68°F of Ethylene Glycol Specification O-A-00548 in Water Mixtures
+20	1-1/2	Issued ready-mixed for 0° to -65°F temperatures for both initial installation and replenishment of losses.	1-1/2	1.022
+10	2		2-1/4	1.036
0	2-3/4		2-3/4	1.047
-10	3-1/4		3-1/4	1.055
-20	3-1/2		3-1/2	1.062
-30	4		4-1/2	1.067
-40	4-1/4		5	1.073

Below -40°, use artic antifreeze compound.

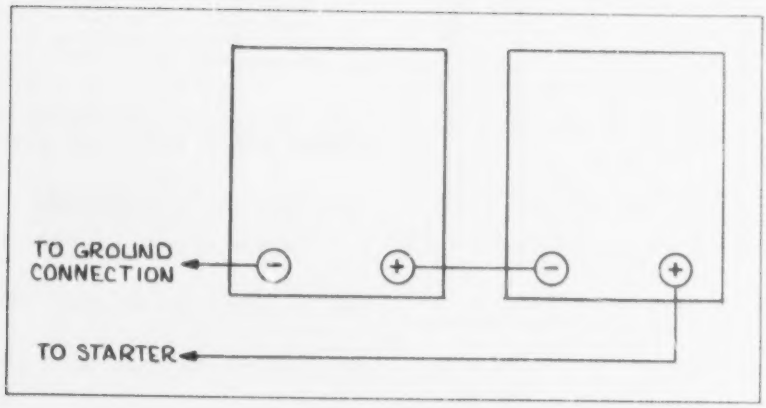


Figure 3-2. Battery Installation and Connections

SECTION IV

OPERATION INSTRUCTIONS

4-1. GENERAL.

4-2. This section provides engine-generator set operating instructions for all climatic conditions and in a procedural step format. To expedite these procedures, the operator should become thoroughly familiar with the location and function of each operating control and indicator. Figure 4-1 and table 4-1 are provided for this purpose. Before operating the engine-generator set, make certain all procedures described in paragraph 3-12 have been performed.

4-3. OPERATING CONTROLS AND INDICATORS.

4-4. The controls and indicators necessary for the operation of the engine-generator set are located on the engine-generator set control panel and the fuel control panel. The engine-generator set control panel is illustrated in figure 4-1. Refer to table 4-1 for a list of these controls and indicators, as well as their function. Refer to table 4-2 for a list of those engine operating controls, together with their function, not located on the control panel.

4-5. PRE-OPERATION SETUP.

4-6. CONTROL PANEL INITIAL SETUP. Prior to starting the engine-generator set, operate the controls and switches on the control panel as indicated in table 4-3.

WARNING

The engine-generator set generates dangerously high voltages which may cause severe or fatel shock to personnel. Safety precautions must be observed at all times. Never make electrical connections while the engine-generator set is operating. Never remove any guards, shields, or screens from the equipment while it is operating.

4-7. INITIAL ENGINE SETUP. Prior to starting the engine-generator set, the following controls should be set as indicated:

CAUTION

Do not operate engine at no load for extended periods.

a. Set UNIT FUEL TANK DRAIN VALVE to OFF position.

b. Set UNIT FUEL TANK SHUT-OFF VALVE to ON position.

c. Set heater air valve to ENGINE POS position.

d. Connect the link bars on the reconnection panel for either 120/208 or 240/416-volt operation. Refer to paragraph 4-8 for reconnection panel setup procedure.

4-8. RECONNECTION PANEL SETUP. Before making any connections on the reconnection panel, lift up the cover guard from the STARTER DISC switch on the control panel and set the switch to the MAINT position. (This is done to prevent accidental starting of the engine-generator set while the link bars connections on the reconnection panel are being made.) Refer to figure 4-2, which illustrates the proper reconnection panel connections for 120/208 or 240/416-volt operation, and set up the reconnection panel in accordance with the voltage and grounding requirements of the electrical load. If the engine-generator set is to be used in single-unit operation, connect the load cables to lower servant posts L3, L2, L1, and L0. If the engine-generator set is to be used in parallel operation with another unit, connect the load cables to the lower servant posts as previously described, and connect the parallel unit to upper servant posts L3, L2, L1, and L0. When making link connection, be sure to bolt links to the applicable connection post located between main connecting posts. After setting up the reconnection panel, set STARTER DISC switch to NORMAL position and return cover guard of switch to protective position.

4-9. PRIMING. If the engine-generator set is to be operated for the first time, after a long period of idleness, or whenever the fuel flow between the set tank and the fuel injection pump has been broken, the system must be primed. To prime the engine-generator set, proceed as follows:

a. Loosen, but do not remove, hose connection at intake port of fuel injection pump.

b. Open valve under set tank until fuel flows in solid stream without any air bubbles. Use a suitable container to catch excess fuel.

c. Tighten hose connection at intake port of fuel injection pump.

d. Close valve under set tank.

4-10. BATTERY CHARGING PROCEDURE. If it is required to recharge the storage batteries prior to starting, an external 28-volt d-c or 120-volt a-c source must be available. To recharge the storage batteries connect external 28-volt d-c source to the POWER RECEPTACLE 28 VDC STARTING or connect 120-volt a-c source to terminals 10 and 11 of terminal board TB2. Set BAT CHGR switch to HIGH position (to charge batteries).

4-11. STANDBY OPERATION. If it is required to preheat the engine-generator set in preparation for starting, and an external 120-volt, 60-Hz, source of power is available, proceed as follows:

a. Check that operating controls on control panel are set to positions indicated in table 4-3.

b. Connect external power source between terminal 10 and terminal 11 of terminal board TB2.

c. Set ELEC HTR switch to ON position.

d. Allow sufficient time for coolant temperature, indicated on coolant temperature meter, to level off at approximately 170°F before starting engine.

4-12. SINGLE-UNIT OPERATION (60-Hz).

4-13. GENERAL. Single-unit operating procedures cover the following aspects of engine-generator set operation.

a. starting
b. operating
c. battery changing
d. remote operation
e. emergency operation
f. stopping

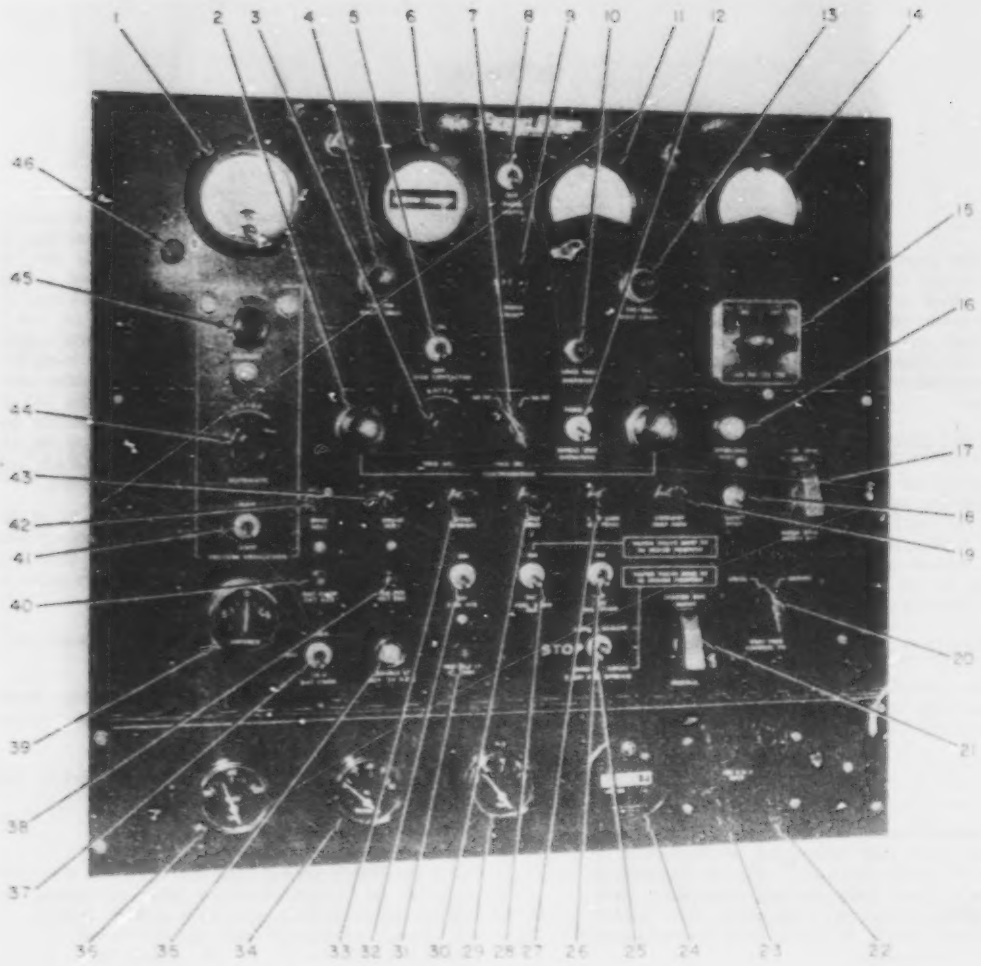


Figure 4-1. Engine-Generator Set Control Panel

TABLE 4-1. ENGINE-GENERATOR SET CONTROL PANEL, OPERATING CONTROLS AND INDICATORS

Control or Indicator	Figure 4-1 Index No.	Function	Ref. Desig.
Wattmeter	1	Indicates electrical power (% load) being delivered by generator to load terminals.	M5
SYNCHRONIZING indicator lamps	2	Used to synchronize paralleled units by blinking when units are not synchronized and by extinguishing when units are synchronized.	DS11, DS12
FREQ ADJ potentiometer	3	Controls raising or lowering of governed engine speed.	R18
240/416 VOLT CONN indicator lamp	4	When lit, indicates that reconnection panel is connected for 240/416-volt output.	DS14

TABLE 4-1. ENGINE-GENERATOR SET CONTROL PANEL, OPERATING CONTROLS AND INDICATORS (Continued)

Control or Indicator	Figure 4-1 Index No.	Function	Ref. Desig.
LOAD CONTACTOR switch	5	Controls application of energizing voltage to load contactor relay that connects generator output voltage to reconnection panel.	S16
A-c frequency meter	6	Indicates frequency of generator output voltage.	M8
FREQ SEL switch	7	Permits operation of under and overvoltage sensing relays and voltage regulator for either 50- or 60-Hz operation.	S30
PANEL LIGHTS switch	8	Contro' ''hting of panel lamps at top of control panel.	S10
UNDER FREQ indicator lamp	9	Press-to-test indicator lamp. When lit, indicates that a low frequency fault has occurred (44Hz).	DS15
LOAD TERM ENERGIZED indicator lamp	10	When lit, indicates that generator output voltage is present at reconnection panel load terminals.	DS10
Load meter	11	A-c ammeter that indicates percent of electrical load capability (based on 0.8 power factor) being delivered by generator.	M7
OPERATION switch	12	Selects either single unit or parallel operation of engine-generator set.	S20
120/208 VOLT CONN indicator lamp	13	When lit, indicates that reconnection panel is connected for 120/208-volt output.	DS13
A-c voltmeter	14	Used to measure generator output voltages.	M6
AM-VM SEL SW	15	Selects which generator phase windings shall be monitored by a-c voltmeter and load meter.	S24
OVERLOAD RESET push-button and relay	16	When depressed, resets overload relay K20 to its normal condition after an overload fault has occurred and been corrected.	K20
SAFETY BYP switch	17	With equipment shut down due to a fault condition, this switch permits reenergizing of the equipment to allow emergency operation. A red safety guard cover prevents accidental tripping of switch.	S5
SAFETY RESET pushbutton	18	When depressed, resets fault circuits to their normal condition after a fault has occurred and been corrected.	S9
COOLANT TEMP HIGH indicator lamp	19	Press-to-test indicator lamp. When lit, indicates that a high coolant temperature fault has occurred (220 ± 10°F).	DS1
VOLT FREQ CONTROL SW	20	Selects either local or remote control of generator voltage and engine speed.	S12
STARTER DISC switch	21	Disconnects starter motor control circuit to prevent accidental starting of engine-generator set during maintenance. A red safety guard cover prevents accidental tripping of switch.	S31
120 V.A.C. RECP	22	Twistite a-c convenience outlet.	J5
120 V.A.C. RECP	23	Standard three-prong a-c convenience outlet.	J4

TABLE 4-1. ENGINE-GENERATOR SET CONTROL PANEL, OPERATING CONTROLS AND INDICATORS (Continued)

Control or Indicator	Figure 4-1 Index No.	Function	Ref. Desig.
Elapsed time meter	24	Indicates total engine-generator set operating time.	M1
START AND OPERATE	25	Selects either remote starting and operation, AUTO & REMOTE position; local starting and operation, MANUAL & LOCAL position; or OFF.	S28
AUX FUEL PUMP switch	26	Controls application of energizing voltage to electric fuel pumps when an auxiliary fuel source is used.	S27
LOW LUBE OIL PRESS indicator lamp	27	Press-to-test indicator lamp. When lit, indicates that a low lubricating oil pressure fault has occurred (10 ± 1 psi).	DS4
FUEL BRNG HTR switch	28	Controls application of energizing voltage to fuel burning heater.	S13
Fuel oil level gage	29	Indicates level of fuel oil in set tank.	M3
OVER SPEED indicator lamp	30	When lit, indicates that an overspeed fault has occurred (between 2070 and 2250 rpm).	DS2
TROUBLE LT CKT BKR	31	Controls energization of trouble light circuit and protects circuit against d-c overload (5-ampere capacity).	CB2
ELEC HTR switch	32	Controls application of external a-c energizing voltage to electric heater during standby operation.	S18
OVER CURRENT indicator lamp	33	Press-to-test indicator lamp. When lit, indicates that an overcurrent fault has occurred (250% to 400% of rated current).	DS3
Lubricating oil pressure gage	34	Indicates lubricating oil pressure of diesel engine.	M2
TROUBLE LT RECP 24 V.D.C.	35	Convenience outlet for 24-volt d-c trouble light.	J3
Coolant temperature gage	36	Indicates temperature of diesel engine coolant.	M9
BAT CHGR switch	37	Selects either HIGH (3-5 amperes) or LOW ('trickle' charge) output from battery charger circuit.	S19
D.C. SYS CKT BKR	38	Controls application of 24-volt d-c power to starting control, and fault systems and protects d-c circuits against overload (15-ampere capacity).	CB3
Battery charging ammeter	39	Indicates current output of battery charging circuit.	M4
BAT CHGR CKT BKR	40	Controls energization of battery charging circuit and protects circuit against overload (10-ampere capacity).	CB1
VOLTAGE REGULATION switch	41	Selects higher manual or automatic voltage regulation of engine-generator set.	S29

TABLE 4-1. ENGINE-GENERATOR SET CONTROL PANEL, OPERATING CONTROLS AND INDICATORS (Continued)

Control or Indicator	Figure 4-1 Index No.	Function	Ref. Desig.
OVER VOLT indicator lamp	42	Press-to-test indicator lamp. When lit, indicates that an overvoltage fault has occurred (145-150 volts a-c for 120/208-volt 60-Hz operation).	DS6
UNDER VOLT indicator lamp	43	Press-to-test indicator lamp. When lit, indicates that an undervoltage fault has occurred (105-110 volts a-c for 120/208-volt 60-Hz operation).	DS5
VOLTAGE REGULATION-AUTOMATIC control	44	Used to set level of generator output voltage for automatic voltage regulation.	R13
VOLTAGE REGULATION-MANUAL control	45	Used to regulate generator output voltage manually.	T7
10 AMP MAN VOLT REG fuse	46	Protects voltage regulator VR1 from damage due to short circuit	F3

TABLE 4-2. ENGINE OPERATING CONTROLS NOT LOCATED ON CONTROL PANEL

Control	Location	Function
Air heater valve	6, Figure 1-4	Controls flow of heated air from fuel burning heater to engine crankcase.

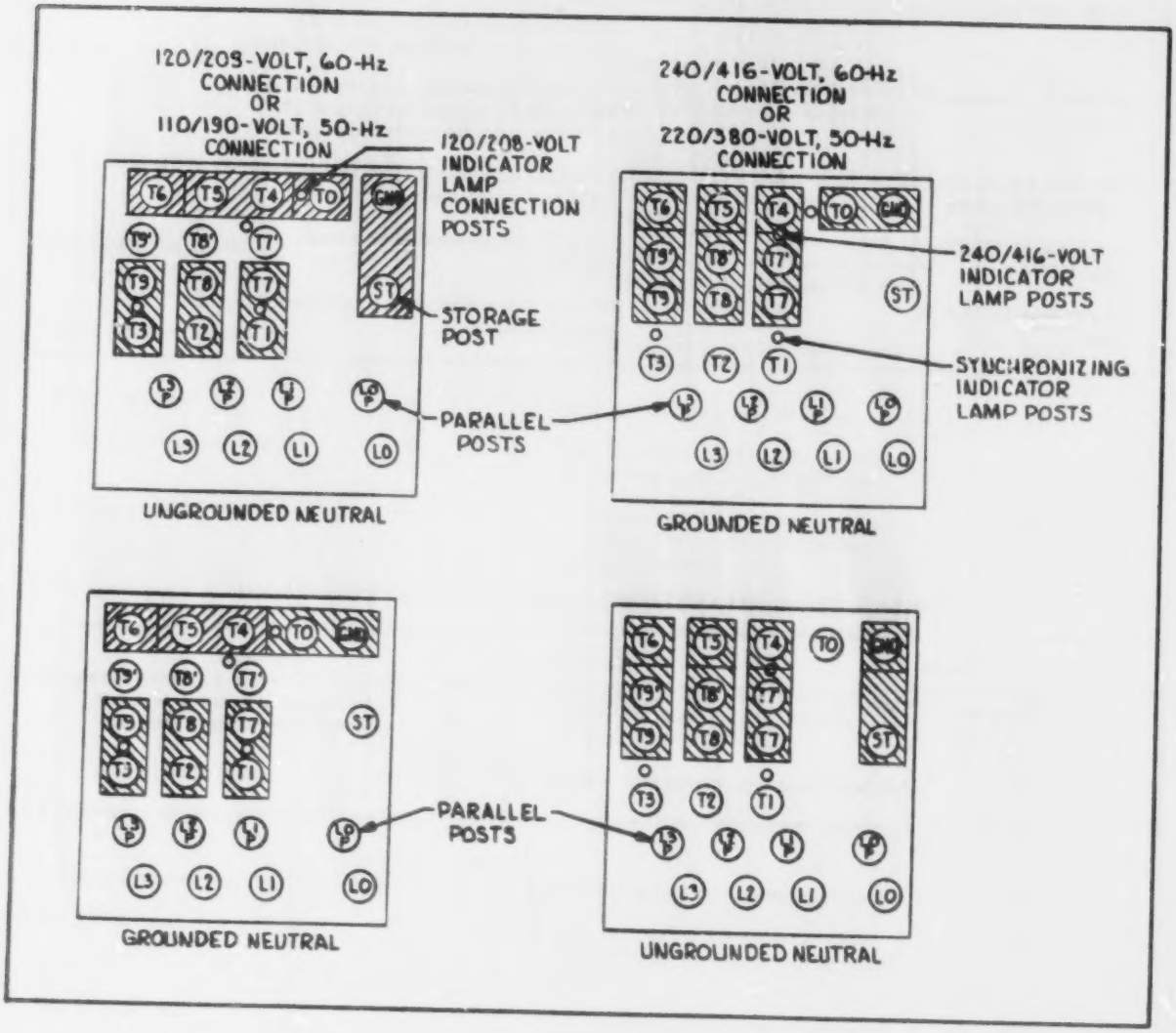


Figure 4-2. Reconnection Panel Setup

TABLE 4-3. OPERATING CONTROLS, INITIAL SETUP

Control	Figure 4-1 Index No. Location	Position
VOLTAGE REGULATION-MANUAL	45	Fully counter-clockwise
VOLTAGE REGULATION-AUTOMATIC	44	Fully counter-clockwise
VOLTAGE REGULATION AUTO-MAN	41	MAN
LOAD CONTACTOR	5	OFF
FREQ ADJ	3	Center
OPERATION	12	SINGLE UNIT
OVERLOAD RESET pushbutton	16	Depress and release
BAT CHGR CKT BKR	40	Depress
D.C. SYS CKT BKR	38	Depress
ELEC HTR	32	OFF
FUEL BRNG HTR	28	OFF
AUX FUEL PUMP	26	OFF
STARTER DISC	21	NORMAL (return cover to protective position)
VOLT FREQ CONTROL SW	20	LOCAL
BAT CHGR	37	OFF
START AND OPERATE	25	STOP
TROUBLE LT CKT BKR	31	Depress
SAFETY RESET	18	Depress and release
SAFETY BYP	17	EMER OPER ONLY
AM-VM SEL SW	15	L1 - L2 PH1

4-14. STARTING. One of three methods may be used to start the engine. The method to be used is dependent upon local weather conditions and is determined as follows:

NOTE

Before proceeding with any of the three starting methods listed in paragraphs 4-15, 4-16, and 4-17, perform the preoperative check indicated in paragraph 3-12. If an external 28-volt d-c source is to be used to crank the diesel engine (as would be required with weak or absent batteries), connect external 28-volt d-c source to POWER RECEPTACLE 28 VDC STARTING.

a. When ambient temperature is between 0 to +71°C (+32 to +128°F) use starting method described in paragraph 4-15.

b. When ambient temperature is between 0 to -13°C (+32 to -25°F) use starting method described in paragraph 4-16.

c. When ambient temperature is between -32 to -55°C (025 to -67°F) use starting method described in paragraph 4-17.

CAUTION

While operating the engine-generator set, the panel doors should be closed.

NOTE

The panels of the housing may be held out of the way be hooking them to hooks, provided for this purpose, at the top of the housing.

4-15. To start the engine when the ambient temperature is between 0 to +71°C (+32 to +128°F), proceed as follows:

a. If auxiliary fuel oil supply is to be used, set FUEL TANK SHUT-OFF VALVE to OFF position and AUX FUEL PUMP switch to ON position.

b. Set START AND OPERATE switch to MANUAL & LOCAL position. Engine-generator set should start.

c. Check engine-generator set for abnormal noises or unusual operating conditions. If abnormal noises or unusual operating conditions exist, shut down engine-generator set by setting START AND OPERATE switch to OFF position. Investigate cause of trouble.

d. If engine-generator set operation is normal, proceed to paragraph 4-18.

4-16. To start the engine when the ambient temperature falls between 0 to -13°C (+32 to -25°F), proceed as follows:

a. If auxiliary fuel oil supply is to be used, set FUEL TANK SHUT-OFF VALVE to OFF position, and AUX FUEL PUMP switch to ON position.

b. Remove cap from ether primer assembly (located beneath operating control panel).

c. Place capsule of ether into primer chamber.

d. Tightly replace cap over primer chamber.

e. Puncture capsule by pressing down on puncturing tool (part of chamber cap).

f. Set START AND OPERATE switch to MANUAL & LOCAL position and pump ether primer. Engine-generator set should start. If engine-generator set does not start, repeat steps b. through f.

g. Check engine-generator set operation for abnormal noises or unusual operating conditions. If abnormal noises or unusual operating conditions exist, shut down engine by setting START AND OPERATE switch to OFF position. Investigate cause of noise or unusual operating conditions.

h. If engine-generator set operation is normal, proceed to paragraph 4-18.

4-17. To start the engine during extremely cold weather conditions, when the ambient temperature falls between -32 to -55°C (-25 to -67°F), proceed as follows:

CAUTION

Make certain fuel burning heater strainer valve is open.

a. Set heater air valve to HEATER POS position.

b. Set FUEL BRNG HTR switch to ON position.

CAUTION

Igniter coil failure will result, due to overheating when start is attempted without fuel being supplied to heater.

NOTE

Allow fuel burning heater to operate for a minimum of one hour before proceeding to next step.

c. Set FUEL BRNG HTR switch to OFF position.

d. Set heater air valve to ENGINE POS position.

WARNING

Incorrect positioning of heater air valve will result in crankcase oil vapors accumulating in heater assembly rendering heater inoperative and creating a fire or explosion hazard.

e. If auxiliary fuel oil supply is to be used, set FUEL TANK SHUT-OFF VALVE to OFF position, and AUX FUEL PUMP switch to ON position.

f. Remove cap from ether primer assembly.

g. Place capsule of ether, into primer chamber.

h. Tightly replace cap over primer chamber.

i. Puncture capsule by pressing down on puncturing tool part of chamber cap).

j. Set START AND OPERATE switch to MANUAL & LOCAL position and pump ether primer. Engine-generator set should start. If engine-generator set does not start, repeat steps f through j.

k. Check engine-generator set operation for abnormal noises or unusual operating conditions. If abnormal noises or unusual operating conditions exist, shut down engine by setting START AND OPERATE switch to OFF position. Investigate cause of noise or unusual, operating conditions.

l. If engine-generator set operation is normal, proceed to paragraph 4-18.

4-18. OPERATING. To operate the engine-generator set after starting, proceed as follows:

a. Adjust VOLTAGE REGULATION-MANUAL control in clockwise (RAISE) direction until a-c voltmeter indicates required output voltage (either 208 or 416 volts).

b. Rotate FREQ ADJ potentiometer to RAISE position until a-c frequency meter indicates 60 Hz.

c. Depress and release SAFETY RESET pushbutton.

d. Set VOLTAGE REGULATION AUTO-MAN switch to AUTO position.

e. Adjust VOLTAGE REGULATION-AUTOMATIC control in clockwise (RAISE) direction until a-c voltmeter indicates required output voltage (either 208 or 416 volts).

f. Depress and release SAFETY RESET pushbutton.

g. Set SAFETY BYP switch to NORM OPER position.

h. Set LOAD CONTACTOR switch to ON position. LOAD TERM ENERGIZED indicator lamp should light.

i. If load requires voltages with a specific phase relationship, and the engine-generator set is delivering voltages with an incorrect phase relationship, first reduce load, then set START AND OPERATE switch to OFF position and proceed to next step.

j. Set STARTER DISC switch to MAINT position.

k. Reverse any two of the phase cable connections going to reconnection panel.

TABLE 4-4. REMOTE CONTROL TERMINAL BOARD CONNECTIONS

Remote Control or Indicator	Connect Between:
Voltage adjust rheostat	TB-2-9 and TB-2-8
Safety bypass switch-1	TB-2-6 and TB-2-7
Safety bypass switch -2	TB-1-9 and TB-1-10
Governor switch	TB-16 and TB-1-17 and TB-1-15
Safety reset pushbutton	TB-1-5 and TB-1-6
Start-stop switch	TB-1-7 and TB-1-8
Crank timer control	TB-1-2 and TB-1-4
Crank lockout	TB-1-18 and transfer panel
Engine fault indicator	TB-2-1 and TB-1-2
Overvolt indicator	TB-2-2 and TB-1-1
Undervolt indicator	TB-2-3 and TB-1-2
Low lubricating oil pressure indicator	TB-1-11 and TB-1-2
Overspeed indicator	TB-1-12 and TB-1-2
High coolant temperature indicator	TB-1-13 and TB-1-1
Load terminal energized indicator	TB-1-3 and TB-2-4

l. Set STARTER DISC switch to NORM position.

m. Reconnect load and set START AND OPERATE switch to MANUAL & LOCAL position. Engine-generator set should start.

n. Set BAT CHGR switch to LOW position if operation is expected to be long and continuous. Set BAT CHGR switch to HIGH position if batteries are weak, or if external 28-volt d-c source (paragraph 4-14) is removed after starting.

4-19. REMOTE OPERATING. The engine-generator set is designed to operate in conjunction with an auto-start non-attached power transfer panel. Remote operating presupposes that the engine-generator set has been adjusted for the required output voltage. If this is not the case and remote starting is desired, then the operator must return to engine-generator set after starting and adjust the control panel for the required output voltage. To operate the engine-generator set from a remote position, proceed as follows:

NOTE

The fuel burning heater cannot be operated from a remote position. Therefore, this equipment must be set locally before switching the engine-generator set to remote operation.

a. Set START AND OPERATE switch to OFF position.

b. Lift up cover guard from STARTER DISC switch and set switch to MAINT position.

c. Remove jumper wires from terminals 2 and 4; 5 and 6; 9 and 10; and 14 and 15 of terminal board TB-1.

d. Remove jumper wire from terminals 8 and 9 of terminal board TB-2. Store all jumper wires in tool box.

e. Connect power transfer panel to engine-generator set as indicated in table 4-4.

f. Set STARTER DISC switch to NORMAL position. Return cover guard to protective position.

NOTE

If it is desired to start engine-generator set from local position, set remote start-stop switch to start position. If it is desired to start engine-generator set from remote position, set remote start-stop to stop (off) stop position.

g. Set VOLT FREQ CONTROL SW to REMOTE position.

h. Set START AND OPERATE switch to AUTO & REMOTE position. Engine-generator set should start if remote start-stop switch is set to start position.

i. Continue to operate engine-generator set in manner described in paragraph 4-12.

4-20. EMERGENCY OPERATING. If an emergency situation occurs and it becomes necessary to operate the engine-generator set despite the existence of a fault condition which coule be

harmful to the engine-generator set, lift up cover guard of SAFETY BYP switch and set switch to EMER OPER ONLY position.

4-21. STOPPING. To stop engine-generator set, remove load from unit. Allow engine to operate at rated speed for 5 to 10 minutes. Place START AND OPERATE switch in OFF position. When certain faults exist the engine-generator set will automatically stop. With other types of faults, the engine-generator set will continue operating, but the generator voltage will be automatically disconnected from the reconnection panel and the exciter field will open. Table 4-5 lists each fault, the protective action that results, and the indication produced on the control panel.

4-22. SINGLE-UNIT OPERATION (50 Hz).

4-23. STARTING. Starting procedure for single-unit operation at 50 Hz is exactly the same as starting procedures for single-unit operation at 60 Hz (refer to paragraph 4-14).

4-24. OPERATING. To operate the engine-generator set after starting, proceed as follows:

a. Set FREQ SEL switch to 50 Hz position.

b. Rotate FREQ ADJ potentiometer until a-c frequency meter indicates 50 Hz.

c. Adjust VOLTAGE REGULATION-MANUAL control for required output voltage (either 190 or 380 volts) as read on a-c voltmeter.

d. Depress and release SAFETY RESET pushbutton.

e. Set VOLTAGE REGULATION AUTO-MAN switch to AUTO position.

f. Adjust VOLTAGE REGULATION-AUTOMATIC control for required output voltage (either 190 or 380 volts) as read on a-c voltmeter.

g. Depress and release SAFETY RESET pushbutton.

h. Set SAFETY BYP switch to NORM OPER position.

i. Repeat steps i through o of paragraph 4-18.

CAUTION

Do not exceed permissive load rating of 75 kilowatts for 50-Hz operation.

4-25. REMOTE OPERATING. Remote operating procedures for single-unit operation at 50 Hz is exactly the same as those for single-unit operation at 60 Hz (refer to paragraph 4-19).

4-26. EMERGENCY OPERATING. Emergency operating procedures for single-unit operation at 50 Hz is exactly the same as those for single-unit operation at 60 Hz (refer to paragraph 4-20).

4-27. STOPPING. Procedures for stopping the engine-generator set for single-unit operation at 50 Hz is exactly the same as those for single-unit operation at 60 Hz (refer to paragraph 4-21).

4-28. PARALLEL OPERATION (50 AND 60 Hz).

4-29. STARTING. The following procedures for parallel operation (50 and 60 Hz) applies to engine-generator sets which are the same models. To operate two or more similar engine-generator sets, proceed as follows:

a. Set controls of both units to positions indicated in table 4-3.

b. Connect both units to a common load (observe correct phase rotation).

c. Connect ground terminals of both units to common ground.

TABLE 4-5. ENGINE-GENERATOR SET FAULT CONDITIONS

Type Fault	Protective Action	Indication
Lubricating oil pressure falls below 10 ± 1 psi.	Engine shuts down and generator disconnects from load.	LOW LUBE OIL PRESS indicator lamp lights.
Coolant temperature exceeds 220 ± 5°F	Engine shuts down and generator disconnects from load.	COOLANT TEMP HIGH indicator lamp lights.
Engine speed exceeds speed limit range of 2070 to 2250 rpm.	Engine shuts down and generator disconnects from load.	OVER SPEED indicator lamp lights.
Generator overcurrent or short circuit.	Generator disconnects from load and exciter field opens. Engine continues to run.	OVER CURRENT indicator lamp lights.
Generator voltage falls below certain preset value for more than 8 seconds.	Generator disconnects from load and exciter field opens. Engine continues to run.	UNDER VOLT indicator lamp lights.
Generator voltage exceeds certain preset value for more than 2 seconds.	Generator disconnects from load and exciter field opens. Engine continues to run.	OVER VOLT indicator lamp lights.
Fuel pressure falls below 35 ± 5 psi.	Engine shuts down and generator disconnects from load.	No indication.
Generator frequency falls below 44 Hz.	Generator disconnects from load and exciter field opens. Engine continues to run.	UNDER FREQ indicator lamp lights.

CAUTION

Insure that both units are connected in the proper voltage connection (figure 4-2) and that both units have the proper phase rotation.

d. Starting with one unit, loosen the lock nut on the governor GAIN control. Turn the control to its extreme ccw position and then turn the control ¼ turn cw. Retighten the lock nut to a torque of 8 to 10 lb-in.

e. Start the unit and operate at full rated load.

NOTE

Should the prime mover (diesel engine) be unstable, stabilize it by loosening the STABILITY adjust lock nut and by turning the STABILITY control cw to overcome short quick oscillations, ccw to overcome long slow oscillations. Retighten the STABILITY adjust lock nut to a torque of 8 to 10 lb-in.

f. Adjust the frequency droop from full load to no load to a value of 2-3 percent of rated frequency. This adjustment is made by turning the droop adjust R3 (22, figure 1-10) cw to increase droop or ccw to decrease droop.

g. Adjust the voltage droop from full load to no load to a value of 3-4 percent of rated voltage. This adjustment is made by moving the slide wire on the voltage droop resistor R14 (located in the control box).

h. Shut the unit down and repeat paragraph 4-29 d through g on other unit.

i. Start one unit and operate with load on. This unit will be referred to as the operating unit.

j. Start the second unit but do not close the LOAD CONTACTOR. This unit will be referred to as the incoming unit.

NOTE

When the second unit is started, the SYNCHRONIZING lamps will start to blink.

k. Adjust the VOLTAGE REGULATION AUTOMATIC control R13 on the incoming unit to match the voltage of the operating unit.

l. Turn the FREQ ADJ control on the incoming unit until the SYNCHRONIZING lamps on the incoming unit blink very slowly.

m. At the instant that the lights are dark, set the LOAD CONTACTOR switch on the incoming unit to the on position.

CAUTION

Care must be exercised so as not to close the load contactor on the incoming unit when the SYNCKONIZING lamps are lit.

n. Adjust the FREQ ADJ control on the incoming unit until the watt meters on both units indicate their proportionate percentage of the load.

o. Adjust the VOLTAGE REGULATION AUTOMATIC control until the current meters indicate their proportional percentage of current.

p. Adjust the FREQ ADJ potentiometer of the incoming unit until the wattmeters on both units indicate their proportional percentage of the load.

q. Adjust the VOLTAGE REGULATION-AUTOMATIC control of both units until the load meter readings on both units are at the lowest value and are equal.

4-30. STOPPING. To stop equipment after parallel operation, proceed as follows:

a. Reduce load to rated value of one unit.

b. Set LOAD CONTACTOR switch on operating unit to OFF position. LOAD TERM ENERGIZED indicator lamp will not be extinguished.

c. Set LOAD CONTACTOR switch on incoming unit to OFF position. LOAD TERM ENERGIZED indicator lamp should become extinguished.

d. Set OPERATION switch on both units to SINGLE UNIT position.

e. Allow 5 minutes for engine temperatures to stabilize before setting START AND OPERATE switches on both units to OFF position.

SECTION V

PERIODIC INSPECTION, MAINTENANCE, AND LUBRICATION

5-1. GENERAL.

5-2. The "daily" or "service" inspection will be performed prior to each dispatch of the unit for that day. Intervals between service inspections shall not exceed twenty-four (24) hours unless the equipment is not scheduled to be used. Equipment will be operationally checked prior to use if it has been on the ready line for seven (7) calendar days.

5-3. The fifty (50) hour inspection intervals will be performed every fifty (50) hours or seven (7) days, whichever occurs first.

5-4. The one hundred (100) hour inspection intervals will be performed every one hundred (100) hours or ninety (90) calendar days, which ever occurs first.

5-5. The maintenance instructions in this section are limited to inspection, cleaning, lubrication, and adjustment.

5-6. PERIODIC INSPECTION.

5-7. Periodic inspection is required to ensure that the engine-generator set is always in proper operating condition. Refer to table 5-1 for the scope and frequency of inspection.

5-8. CLEANING.

5-9. GENERAL. To perform general cleaning, proceed as follows:

a. Wash rubber parts with soap and water and rinse with clear water. Allow sufficient time for drying.

b. Use solvent, Federal Specification P-S-661, and a brush to clean metal parts. Allow sufficient time for drying then coat with thin film of oil to prevent corrosion.

c. Clean all non-ferrous metals with solvent, Federal Specification P-S-661, using a brush or cloth as applicator.

d. Using compressed air, blow dust and dirt out of interiors, corners, and crevices.

e. Wipe all flat surfaces with cloth dampened with solvent, Federal Specification P-S-661.

5-10. LUBRICATING OIL FILTER. To clean lubricating oil filter, proceed as follows:

a. Remove drain plug from filter case and allow oil to drain.

b. Loosen center bolt and remove filter case from filter head.

c. Withdraw dirty filter element.

NOTE

Inspect for metal particles. If metal is found, a check of connecting rods and main bearings should be made at once.

d. Remove seal ring from filter head and discard.

e. Clean filter case thoroughly.

f. Check to make sure element end seals are in place and install new element over pilot valve assembly.

g. Position new seal ring in place; assemble filter case to head and tighten center bolt to 25/35 foot-pounds.

h. Check oil level. Run engine and check for leaks.

i. Recheck engine oil level; add oil as necessary to bring oil level to "H" mark on dipstick.

NOTE

Always allow oil to drain back to oil pan before checking level.

5-11. FUEL FILTER. To clean fuel filter, proceed as follows:

a. Remove cover from top of filter.

b. Remove cartridge from filter body.

c. Clean out filter body.

NOTE

Do not remove spacer from center tube.

d. Install new cartridge.

e. Install new cover gasket.

f. Replace cover.

g. Add oil to compensate for filter.

h. Run engine for five minutes and check for leaks.

i. Recheck oil level.

5-12. FUEL INJECTION PUMP. To clean fuel injection pump, proceed as follows:

a. Remove cap at top of fuel pump.

b. Lift out filter screen assembly.

c. Separate screen retainer and magnet.

d. Clean screen and magnet in cleaning solvent.

WARNING

Wear protective goggles when using compressed air.

e. Dry screen and magnet with compressed air.

TABLE 5-1. PERIODIC INSPECTION

Component	Nature of Inspection	Inspection Period (Elapsed Time Meter Hours)		
		Daily	50	100
	UNIT HOUSING			
ENTIRE UNIT	Remove accumulated dirt, especially from louvers and radiator shutter.		X	X
	Inspect access doors for damage, proper opening and closing.		X	X
	FUEL SYSTEM			
FUEL SUPPLY	Check fuel level; if necessary, add JP-4 fuel, Specification MIL-F-5624, or diesel fuel, Federal Specification VV-F-800.	X		
	Inspect fuel tanks and lines for leakage.	X	X	X
	Replace fuel strainer and filter			X
	Drain some fuel from bottom of set tank through FUEL TANK DRAIN VALVE to eliminate water and sediment.	X		
	Replace fuel pump filter.	(Every 100 hours of fuel pump operation)		
	Drain fuel heater sediment bowl.	(Every 24 hours of heater operation or sooner, if necessary)		
	OIL SYSTEM			
OIL SUPPLY	Check oil level in engine crankcase. If necessary, add oil.	X		
	Check crankcase breather for cleanliness.		X	
	Change oil in air cleaner and crankcase.			X
	Change oil and filter cartridges			X
	COOLING SYSTEM			
RADIATOR	Check coolant level. If required, add coolant (Refer to Section III.)	X		
	Check pressure cap.		X	
	Check for free movement of radiator shutters.	X		
	Inspect coolant hose for leaks and connections for tightness.		X	X
WATER PUMP	Check for proper lubrication.	(As required)		
	BATTERIES			
BATTERIES	Inspect battery cables for tightness and signs of corrosion.		X	X
	Check battery electrolyte level and specific gravity (Sp. Gr. 1.280 ±0.005 at 77°F or 25°C).	X	X	X
	CONTROL SYSTEM			
CONTROL PANEL	Check LOAD CONTACTOR switch for proper ON-OFF operation.			X
	Inspect all electrical connections for tightness and wires for damage.			X
	Check for burned-out bulbs.		X	X

TABLE 5-1. PERIODIC INSPECTION (Continued)

Component	Nature of Inspection	Inspection Period (Elapsed Time Meter Hours)		
		Daily	50	100
	CONTROL SYSTEM			
CONTROL PANEL (cont)	Check all switches for proper operation.		X	X
	Check all gages for proper reading.	X	X	X
	Unfasten and lower hinged panel. Inspect all interior wiring for damage and for tightness of connections.		X	X
	STARTING SYSTEM			
STARTER MOTOR	Check starter for security of mounting, condition of housing and tightness of housing bolts.			X
	Check brushes. Minimum brush length should be 9/16 inches.	(Every 500 hours)		
	Check for dirty or rough commutator. Clean with number 00 sandpaper, Navy Class F commutator stone or equivalent.	(Every 500 hours)		
	Check brush holders and insulators to make certain parts are not broken or tapped holes stripped.	(Every 500 hours)		
	Check brush holders spring tension. Spring tension should be 45 to 50 ounces.	(Every 500 hours)		
	Check starter switch for security of mounting and condition of leads.	(Every 500 hours)		
	GENERATOR GROUP			
GENERATOR	Clean generator inside and out. Wipe all loose dirt from covers before removing.			X
	Inspect all power leads for signs of damage. Check all connections for tightness.			X
	Inspect outer casing for discoloration and other signs of overheating.			X

f. Reinstall screen and magnet assembly in fuel pump.

g. Replace fuel pump cap and tighten to 20-25 ft lbs torque.

5-13. ELECTRIC FUEL PUMP. To clean the electric fuel pump, proceed as follows:

a. Remove fuel filter element from bottom of fuel pump.

b. Replace fuel filter element.

5-14. CRANKCASE BREATHER FILTER. To clean crankcase breather filter, proceed as follows:

a. Remove filter from breather pipe.

b. Thoroughly clean filter in cleaning solvent.

c. Dry filter with compressed air.

d. Reinstall filter in breather pipe.

5-15. FUEL OIL FILTER. To clean fuel filter element, proceed as follows:

a. Loosen hex nut at top of filter.

b. Remove dirty element.

c. Clean element case.

d. Install new filter element.

e. Install new gasket in filter head and assemble element.

f. Tighten center bolt to 20-25 ft lbs torque.

g. Fill filter case with clean fuel.

h. Check fittings in filter head for leaks by operating engine, and tighten to 30-40 ft lbs torque.

5-16. AIR CLEANER TRAY SCREEN. To clean air cleaner tray screen, proceed as follows:

a. Loosen wing nuts securing tray to cleaner body.

b. Remove tray from cleaner.

c. Immerse tray incleaning solvent and slosh tray up and down until flow of solvent through screen is clear.

NOTE

If tray screen is extremely dirty or coated with varnish, singe screen with flame. Use care not to melt tin coating on screen.

d. Dry screen thoroughly with compressed air.

e. Reassemble tray to air cleaner.

5-17. FUEL INJECTORS. To clean fuel injectors, proceed as follows:

a. Start and thoroughly warm engine (see Section IV).

b. Stop engine.

c. Loosen injector jam nut.

d. Loosen half of injector adjusting screws 1 turn from bottom or 1-1/4 turn from set position.

e. Lock injector with jam nut.

f. Start and accelerate engine with maximum throttle from idle to high idle 10 to 15 times.

NOTE

Difficult starting, heavy exhaust smoke, and sluggish throttle response can be expected.

g. Readjust injectors to original setting.

h. Repeat steps c through g for remaining injectors.

5-18. FUEL INJECTOR INLET SCREENS. To clean fuel injector inlet screens, proceed as follows:

a. Unscrew fuel inlet connector and remove from head.

b. Remove inlet screen from connector.

c. Wash screen in solvent and dry with compressed air.

d. Replace screen in connector.

e. Replace fuel inlet connector in head.

5-19. STARTER MOTOR. To clean starter motor, proceed as follows:

a. Remove brush cover band from motor.

b. Blow all dust from motor with compressed air.

c. Replace brush cover band.

5-20. ELECTRICAL CONNECTIONS. To clean electrical connections, proceed as follows:

a. Remove corrosion from and around battery terminals.

b. Tighten battery cable connectors.

c. Coat terminals and connectors with vaseline or light grease.

d. Clean and tighten all electrical control wiring connections through system.

5-21. ENGINE. To clean diesel engine, proceed as follows:

a. Cover starter motor, all wiring, and fan belts with cloth or other protective covering.

b. Using steam under pressure, clean all surfaces of engine and surrounding housing and frames.

c. Remove protective coverings.

5-22. CRANKCASE. To clean the crankcase, proceed as follows:

a. Drain lubricating oil system, including oil filters.

b. Remove all oil filter cartridges.

c. Replace oil filter cartridges with new cartridges.

d. Close the radiator shutters.

e. Prepare flushing oil, in a quantity equal to normal capacity of lubricating oil system, by mixing five parts of fuel with one part of lubricating oil.

f. Fill crankcase with flushing oil.

g. Start engine-generator set.

h. Operate engine-generator set for a period of approximately fifteen minutes. Allow coolant temperature to rise to approximately 190°F (85°C).

i. Shut down engine-generator set, drain flushing oil, and refill crankcase with appropriate lubricating oil.

5-23. COOLANT SYSTEM. To clean coolant system, proceed as follows:

a. Drain all water from coolant system.

b. Disconnect upper and lower radiator hoses from engine block.

c. Screw radiator cap on tight.

d. Using a standard pressure flushing gun, let water run into radiator until it is full.

e. When full, apply air pressure gradually to avoid damage to radiator core.

f. Shut off air and allow radiator to refill with water.

g. Repeat this procedure until water forced from radiator is clear and clean.

h. Apply same procedure or cleaning of block as follows:

i. Remove thermostats from housing and flush block with water. Openings in bottom of block should be restricted until block refills with water.

j. Apply air pressure gradually to top radiator hose connection on block. This will force water from lower block connector.

k. Repeat process until water flowing from lower block connector is clear and clean.

5-24. LUBRICATION.

5-25. Lubrication for the engine-generator set consists of lubricating the water pump and fan hub, and the running gear. All other components of the engine-generator set requiring lubrication are self-lubricating. Refer to the current lubrication order.

5-26. WATER PUMP AND FAN HUB. To lubricate the water pump and fan hub, proceed as follows:

a. Disassemble water pump and fan hub (refer to Section VI, paragraph 6-13).

b. Clean all parts of water pump and fan hub.

c. Reassemble water pump and fan hub.

d. Pack water pump and fan hub bearings 1/2 to 2/3 full of grease.

5-27. RUNNING GEAR. To lubricate the running gear of wheel-mounted engine-generator set, proceed as follows:

a. Lubricate parts of running gear as indicated in table 5-2.

b. Using an oil can filled with engine oil, Specification MIL-L-2014, lubricate every 30 days brake control linkage, brake cable, pillow blocks, and moving connections.

NOTE

In extreme cold weather use oil, Specification MIL-O-10295.

5-28. ADJUSTMENTS.

5-29. Paragraphs 5-30 through 5-38 describe the adjustment procedures necessary for proper engine-generator operation.

5-30. FUEL BURNING HEATER. To adjust the flame detector switch in the fuel burning heater, proceed as follows:

a. Remove flame detector switch as described in Section VI, paragraph 6-54.

b. Check bow spring (see figure 5-1) to see if the tension of quartz rod is causing it to bow up toward top of switch.

NOTE

If spring is not bowed and is in a straight position, the quartz rod is probably broken and must be replaced. (Refer to Handbook of Overhaul Instructions.)

c. Loosen two switch mounting screws until microswitch can pivot.

d. Back off adjusting screw until switch makes clicking noise.

e. Turn adjusting screw in until switch again makes clicking noise and then turn screw an additional 3/4 of a turn past point at which second clicking noise is heard.

f. Tighten two switch mounting screws to secure switch in position.

5-31. FUEL INJECTORS AND VALVES. To adjust fuel injectors and valves, proceed as follows:

a. Using a bar, (through access port in bell housing) rotate gear at end of crankshaft in direction of engine rotation, to No. 1 top center firing position. In this position, intake and exhaust valves are closed.

CAUTION

Do not rotate crankshaft by pulling on fan blades.

b. Continue to slowly rotate crankshaft until valve set mark on water pump drive pulley aligns with timing mark on gear case cover. When these marks align, engine is in position to adjust injector and valves for No. 1 cylinder.

NOTE

Engine firing order is cylinders 1-5-3-6-2-4.

c. Check valve position of cylinder to be adjusted. See that valves are closed and rocker levers are free.

d. Check threads on adjusting screw and nut. See that they are clean, well oiled, and free turning.

e. Turn injector adjusting screw down until plunger contacts cup.

f. Turn adjusting screw an additional 15 degrees to squeeze oil from cup.

g. Loosen adjusting screw one turn.

h. Using a torque wrench, tighten adjusting screw to the torque value listed on the specific engine injector adjustment plate.

i. Lock screw in place with jam nut. Tighten to 25 to 30 in. lbs torque.

NOTE

Prior to adjusting valves, it is first necessary to adjust valve crossheads. Steps j through m provide the procedure for crosshead adjustment.

j. Loosen valve crosshead adjusting locknut (see figure 5-2) and loosen adjusting screw one turn.

k. Use light finger pressure at rocker lever contact surface to hold crosshead in contact with valve stem.

l. For new crossheads and guides, advance the crosshead adjusting screw an additional one-third hex (20° of arc) to straighten stem in its guide and to compensate for slack in threads. With worn crossheads and guides, it may be necessary to advance screw as much as one-half hex (30°) in order to straighten stem in its guide.

m. Lock adjusting screw in this position. Adjust both intake and exhaust crossheads in this manner.

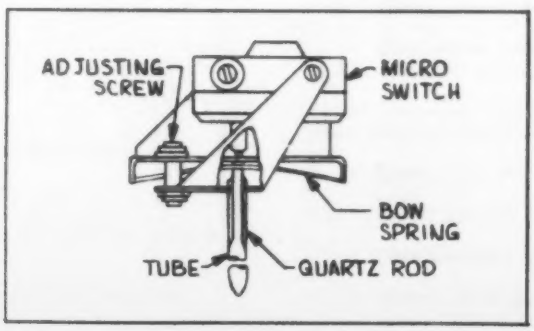


Figure 5-1. Flame Detector Switch Adjustment

NOTE

Engine must attain normal operating temperature before making valve adjustments as outlined in steps n through s.

n. Loosen locknut and adjusting screw.

NOTE

Use feeler gage of 0.016 inches for intake valves and 0.029 inches for exhaust valves.

o. Insert feeler gage of proper thickness between rocker lever and top of valve stem or crosshead.

p. Turn screw down until it just touches feeler gage.

q. Lock adjusting screw in position with jam nut.

r. Recheck clearance after tightening jam nut.

s. Repeat steps n through r for remaining valves. Continue to turn crankshaft with bar to permit proper adjustment of valves.

NOTE

Two crankshaft rotations are necessary to adjust all valves and injectors. Only one cylinder may be adjusted at any one crankshaft setting.

5-32. OVERSPEED SWITCH. To adjust the overspeed switch, proceed as follows:

a. Remove dust cover screw (marked 1 for low speed adjustment screw and 2 for high speed adjustment screw) of overspeed switch.

b. Insert 1/16 inch Hex Allen wrench into adjusting screw.

c. Turn clockwise to increase trip point of switch and counterclockwise to decrease trip point of switch. Switch must trip between 2070 and 2250 rpm.

CAUTION

If adjusting screws are turned in too far, associated switch will become inoperative. Do not attempt to use slots in cap for normal speed adjustments.

5-33. FAN BELT TENSION. To adjust fan belt tension, proceed as follows:

a. Loosen fan hub lock.

b. Adjust belt to desired tension by raising or lowering fan with adjusting capscrew.

c. Tighten locknut to 425 ft lbs torque.

NOTE

Tighten belt tension until pressure deflection applied at middle of span is equivalent to approximately one belt thickness for each foot of belt free span. Following installation of a new belt, run in new belt for at least one hour and then recheck and readjust tension if necessary.

5-34. SIDE DOOR LOUVER CONTROLS. To adjust the louver control units, proceed as follows:

a. Loosen the locknut on the power element.

b. Perform adjustment by turning element until the distance between the base of the element and the locknut (when seated on the control housing) is 1/2 to 5/8 inches.

c. Tighten locknut. Louver should now begin to open at 55°F and be in the full open position at 80°F.

NOTE

Louvers will remain open in ambient temperature above 80°F.

5-35. ELECTRICAL GOVERNOR ACTUATOR ASSEMBLY. Adjust the injection pump throttle valve to the full open position, and lock. Move the actuator connecting link up and down by hand. The link should move from 0.005 in. to 0.010 in. If adjustment is necessary, loosen the drive arm bolt, rotate the arm slightly on the actuator shaft, and re-tighten the bolt.

5-36. MAGNETIC PICKUP. The magnetic pickup is adjusted as follows:

a. Loosen the hex nut on the magnetic pickup so the unit can be rotated freely.

b. Adjust the unit until the distance between the tip of the pickup and the top of a ring gear tooth is from 0.020 in. to 0.035 in. (approximately 1/2-turn out).

c. Tighten the hex nut on the pickup.

5-37. ELECTRONIC GOVERNOR COMPUTER. Any replacement or adjustment of the electronic governor computer EG1-C must be accomplished at overhaul level. (Refer to T.O. 35C2-3-340-13 for instructions.)

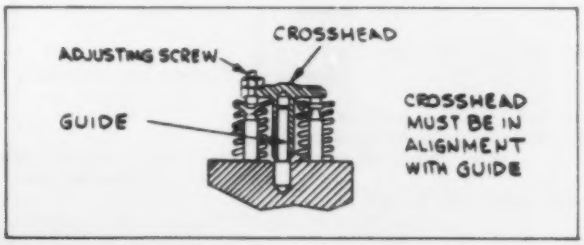


Figure 5-2. Alignment of Crosshead Stem and Guide

SECTION VI

TROUBLE SHOOTING

6-1. GENERAL.

6-2. Trouble shooting involves the detection and location of faulty operation of the equipment and the correction of the fault. Most operational difficulties have definite symptoms which serve as indications to the cause of trouble. Maintenance personnel should learn to recognize and use the symptoms as aids in trouble shooting. The trouble shooting information listed in table 6-1 is provided for this purpose. Refer to paragraphs 6-5 through 6-57 for parts replacement procedures that may be done by maintenance personnel.

6-3. TROUBLE SHOOTING TABLE.

6-4. The trouble shooting table provided in table 6-1 lists the mechanical and electrical faults that can occur during operation of the engine-generator set. If the fault circuits are energized, the diesel engine will shut down, the generator will be disconnected from the load, and the exciter field will be inhibited. After the fault has been located and corrected, the SAFETY RESET pushbutton on the control panel must be depressed in order to restore the fault circuits to their normal position. Isolation of electrical troubles is accomplished by means of continuity checks using the simplified schematic diagrams in Section I and the overall schematic and wiring diagrams shown in figures 6-3 and 6-4.

WARNING

Before trouble shooting the equipment, make certain that the engine-generator set is shut down and that the STARTER DISC switch on the control panel is set to the MAINT position.

6-5. PARTS REPLACEMENT.

6-6. The following paragraphs give the procedures for parts replacement that may be done by field maintenance personnel.

6-7. STARTER MOTOR.

6-8. REMOVAL. To remove starter motor, proceed as follows:

a. Disconnect wiring leads from starter motor terminals.

b. Remove the three capscrews holding the starter motor and mounting spacer to the flywheel housing and lift out.

6-9. INSTALLATION. To install starter motor, proceed as follows:

a. Check starter motor to see if it is same type as removed.

NOTE

Starter motors are designed with different type drives and must be matched with the flywheel ring gear.

b. Assemble spacer to starter motor.

c. Mount starter motor to flywheel housing with three capscrews.

d. Replace wiring leads to starter motor terminals.

6-10. COOLANT THERMOSTAT.

6-11. REMOVAL. To remove coolant thermostat, proceed as follows:

a. Drain Coolant.

b. Disconnect hose from coolant outlet connection on thermostat housing.

c. Remove four capscrews holding thermostat housing to cylinder head coolant outlet connection and separate the two units.

d. Remove thermostat and remove and discard gasket.

6-12. INSTALLATION. To install coolant thermostat, proceed as follows:

a. Install new or tested thermostat using a new gasket. Install thermostat with V notch at top to vent as much air as possible.

CAUTION

Failure to install thermostat with V notch at top may result in an air lock which would restrict coolant circulation.

b. Install four capscrews and washers and tighten securely. Connect coolant outlet hose and tighten clamp.

c. After filling cooling system with prescribed coolant (table 3-1) open drain cock at top of thermostat housing to bleed out air.

6-13. WATER PUMP.

6-14. REMOVAL. Removal of the water pump requires the removal of the fan and fan pulley.

6-15. REMOVAL OF FAN AND FAN PULLEY. To remove fan and fan pulley, proceed as follows:

a. Remove fan from fan pulley.

b. Loosen adjusting screw and remove fan hub, pulley, and belts.

6-16. REMOVAL OF WATER PUMP. To remove water pump, proceed as follows:

a. Loosen six capscrews that secure water pump to cylinder block.

b. Using a screw driver in holes provided in water pump housing, turn water pump to the lowest point of its eccentric to loosen water pump belt.

c. Remove water pump belt.

d. Remove water pump from cylinder block.

6-17. INSTALLATION OF WATER PUMP. To install water pump, proceed as follows:

a. Place gasket on water pump.

TABLE 6-1. TROUBLE SHOOTING TABLE

Trouble	Probable Cause	Remedy
Engine fails to start.	Fuel tank empty.	Check and fill fuel tank if required.
	Incorrect grade of fuel.	Check grade of fuel. Drain fuel system and refill with correct grade of fuel, if required.
	Water in fuel system.	Drain fuel system and refill with correct grade of fuel.
	Air leaks in fuel lines.	Check for air leaks in fuel system and correct if required.
	Restricted fuel lines.	Check fuel lines for restriction.
	Plugged injector spray holes.	Check injector spray holes and clean if required.
	Injector inlet screen dirty.	Clean injector inlet screen.
	Fuel pump screen and magnet dirty.	Clean screen and magnet.
	Fuel pump lever stuck in shut-off position.	Locate and correct cause of trouble.
	Fuel pump defective.	Replace fuel pump.
	Crankcase oil too heavy for weather conditions.	Use correct viscosity oil.
	Air Cleaner dirty.	Check and service air cleaner if required.
	Restricted air intake.	Check inlet air restriction and correct if required.
	Jumper not connected between terminal boards TB1-2 and TB1-4.	Check that jumper is connected between these two terminal boards.
	Batteries BT1 and BT2 weak, dead, or defective.	Check condition of each battery. If batteries are weak, dead, or defective, plug external 28 (or 24)-volt d-c source into receptacle J6, placarded POWER RECEPTACLE 28 VDC STARTING. Remove external d-c source after engine starts. If batteries are weak or dea, set BAT CHGR switch S19 to HIGH position to charge batteries. If external source is removed BAT CHGR switch must be in HIGH position to keep engine running.
	Loose battery cable connections.	Tighten all battery cable connections.
	D.C. SYS CKT BKR CB3 defective.	Check CB3 and replace if required.
	START AND OPERATE switch S28 defective.	Check MANUAL & LOCAL contacts of switch S28 and replace switch if required.
	Engine fuel shut-off solenoid L1 defective.	Solenoid L1 does not energize. Check and replace shut-off solenoid if required.
	STARTER DISC switch S31 defective.	Check NORMAL contacts of switch S31 and replace switch if required.
	A contacts of relay K4 dirty or pitted.	Check contacts and clean if required.
	A contacts of speed sensing switch S1 dirty or pitted.	Check contacts and replace switch if required.
	Lube oil pressure switch S2 dirty or pitted.	Check switch S2 and replace switch if required.
	Coil or A contacts of relay K2 defective.	Check coil and A contacts of relay K2. Clean contacts or replace relay, if required.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Engine fails to start. (Cont)	Starter motor B1 defective.	Replace starter motor.
	Coil or contacts of relay K30 defective.	Check K30 and replace if necessary.
Engine fails to start. Actuator EG1-A does not move to full fuel position when power is applied.	Actuator EG1-A metering valve piston binding.	Replace valve.
	Defective actuator EG1-A windings.	Replace EG1-A.
	Defective control unit EG1-C.	Replace EG1-C (overhaul level).
Engine fails to start. Actuator EG1-A moves to full fuel position when power is applied.	Low engine rail line pressure.	Adjust fuel pump throttle valve to full open position and lock.
	Actuator EG1-A drive arm incorrectly adjusted.	Readjust arm.
Engine fails to start from remote location.	Jumper between terminal boards TB1-2 and TB1-4 not removed.	Check that jumper between these two terminal boards is removed.
	START AND OPERATE switch S28 defective.	With remote start-stop control closed, check AUTO & REMOTE contacts of S28. Replaces S28 if required.
	B contacts of relay K2 defective.	Check contacts and clean if required.
	Remote crank timer control on transfer panel defective.	With remote crank timer control closed, check that continuity exists between terminal boards TB1-2 and TB1-4.
After engine starts, starter motor B1 not deenergized.	A contacts of speed sensing switch S1 do not close.	Check contacts and replace S1 if required.
Engine hunts or surges.	Actuator EG1-A metering valve piston sticking.	Replace valve.
	Magnetic pickup EG1-P loose.	Reset pickup air gap and secure mounting hardware.
	Binding actuator EG1-A lever.	Clean actuator interior.
	Defective capacitor C21 or C22.	Check capacitors and replace if necessary.
When an engine fault occurs, appropriate fault indicator lamp does not light, and engine does not stop.	SAFETY RESET pushbutton S9 defective.	Check switch S9 and replace if required.
	Jumper not connected between terminal boards TB1-5 and TB1-6.	Check that jumper is connected between these two terminal boards.
	Relay K4 defective.	Check relay K4 and replace if required.
	Engine fuel shut-off solenoid valve L1 stuck in open position.	Check valve and replace L1 if required.
Engine stops due to low lube oil pressure. LOW LUBE OIL PRESS, indicator lamp DS4 lights.	Crankcase lube oil level low.	Check engine crankcase lube oil level with dipstick and add oil if necessary.
	Oil leaks in lube oil line.	Check for external leaks in lube oil system and correct if necessary.
	Restricted lube oil line.	Check lube oil lines for restriction.
Engine stops due to low lube oil pressure. LOW LUBE OIL PRESS, indicator lamp DS4 does not light.	Indicator lamp DS4 defective.	Depress pushbutton lamp DS4. If lamp does not light, replace lamp.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Lube oil pressure gage indicates low pressure but engine does not stop.	Lube oil gage M2 not grounded.	Ground gage.
	Relay K18 defective.	Check relay K18 and replace if required.
	Low lube oil pressure switch S8 stuck in open position.	Check switch S8 and replace if required.
	Coil or B contacts of relay K6 defective.	Check coil and B contacts of relay K6. Clean contacts or replace relay, if required.
	Relay K3 defective.	Check relay K3. Clean contacts or replace relay, as required.
	A contacts of relay K9 dirty or pitted.	Check contacts and clean if required.
Engine stops due to engine overspeed. OVERSPEED indicator lamp DS2 lights.	Improper throttle setting.	Check throttle setting and adjust if required.
	Open circuit in electric governor magnetic pickup EG1-P leads.	Repair or replace lead.
	Magnetic pickup EG1-P leads shorted to each other.	Repair or replace leads.
	Magnetic pickup EG1-P lead from control unit grounded.	Repair or replace lead.
	Faulty coil in magnetic pickup EG1-P.	Replace magnetic pickup.
	Incorrect air gap between magnetic pickup EG1-P and gear teeth.	Reset air gap.
	Tip of magnetic pickup EG1-P damaged.	Replace magnetic pickup.
	Excessive fuel leakage through electric governor actuator EG1-A metering valve.	Replace actuator.
Engine stops due to overspeed. OVERSPEED indicator lamp DS2 does not light.	Indicator lamp DS2 defective.	Depress pushbutton lamp DS2. If lamp does not light, replace lamp.
Engine speed excessive as indicated by increased frequency (more than 60Hz) on a-c frequency meter. Engine does not stop and OVERSPEED indicator lamp DS2 does not light.	Overspeed switch S7 stuck in open position.	Check switch S7 and replace if required.
	Relay K8 defective.	Check relay K8 and replace if required.
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 lights.	Insufficient coolant.	Check cooling system and fill with coolant if required.
	Coolant thermostat defective.	Check coolant thermostat and replace if required.
	Radiator shutters stuck closed.	Free radiator shutters for manual operation.
	Radiator shutter thermostat defective.	Check shutter thermostat and replace if defective.
	Damaged water hose.	Check water hose and replace if required.
	Fan belt not adjusted properly.	Check fan belt for required tension and adjust if required.
	Coating of calcium salts on inside of cooling system.	Clean cooling system.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 lights. (Cont)	Radiator core openings plugged with dirt.	Blow out with compressed air.
	Water pump not operating properly.	Check water pump and replace if required.
	Exhaust pipes restricted. Usually accompanied by a hissing sound in exhaust.	Clean pipes and remove restriction.
	Engine overloaded.	Check output load and reduce if required.
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 does not light.	Indicator lamp DS1 defective.	Depress pushbutton lamp DS1. If lamp does not light, replace lamp.
Coolant temperature high as indicated on coolant temperature gage. Engine does not stop and COOLANT TEMP HIGH indicator lamp DS1 does not light.	Thermal switch S6 stuck in open position.	Check switch S6 and replace if required.
	Relay K7 defective.	Check relay K7 and replace if required.
Engine stops due to low fuel pressure.	Fuel pump defective.	Replace fuel pump.
	Fuel pressure switch S17 does not open at required fuel pressure.	Check switch S17 and replace if required.
Engine does not stop due to low fuel pressure.	Fuel pressure switch S17 stuck in open position.	Check switch S17 and replace if required.
Undervoltage condition occurs. UNDER VOLT indicator lamp DS5 lights.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
Undervoltage condition occurs. UNDER VOLT indicator lamp DS5 does not light.	Indicator lamp DS5 defective.	Depress pushbutton lamp DS5. If lamp does not light, replace lamp.
	Voltage frequency monitor K13 defective.	Replace K13.
Overvoltage condition occurs. OVER VOLT indicator lamp DS6 lights.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
Overvoltage condition occurs. OVER VOLT indicator lamp DS6 does not light.	Indicator lamp DS6 defective.	Depress pushbutton lamp DS6. If lamp does not light, replace lamp.
	Voltage frequency monitor K13 defective.	Replace K13.
Overcurrent condition exists. OVER CURRENT indicator lamp DS3 does not light.	Indicator lamp DS3 defective.	Depress pushbutton lamp. If lamp does light, replace lamp.
	Current transformers T1, T2, or T3 defective.	Check transformers and replace if required.
	Kilowatt transducer D1 defective.	Check output excitation of kilowatt transducer at terminals S1, S2, and S3. If excitation is absent, replace kilowatt transducer D1.
	OVERLOAD RESET pushbutton relay K20 defective.	Check coils of relay K20 and replace relay if required.
	Relays K10, K26, or K27 defective.	Check relays and replace if required.
	Voltage frequency monitor K13 defective.	Check K13 and replace if necessary.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
When a generator fault occurs, exciter field is not disconnected.	Relay K9 defective.	Check relay K9 and replace if required.
	OVERLOAD RESET pushbutton K20 does not open.	Check pushbutton K20 and replace pushbutton relay if required.
When an engine fault occurs, generator load is not disconnected.	C contacts of relay K6 do not open.	Check contacts and replace relay K6 if required.
	Relay K3 defective.	Check relay K3 and replace if required.
Battery charging ammeter M4 fails to indicate presence of charging current.	Ammeter M4 defective.	Check ammeter M4 and replace if required.
	Battery charging transformer T6 defective.	Check transformer T6 and replace if required.
	Battery charging rectifier CR1 defective.	Check rectifier CR1 and replace if required.
	Variable resistors R2 or R3 defective.	Check R2 and R3 and replace if required.
	BAT CHGR switch S19 defective.	Check switch S19 and replace if required.
	B and C contacts, or coil, of relay K24 defective.	Check relay K24. Clean contacts or replace relay as required.
	BAT CHGR CKT BKR CB1 defective.	Check CB1 and replace if required.
During standby operation, lube oil and coolant does not warm up or maintain temperature.	ELEC HTR switch S18 defective.	Check switch contacts S18-1 and replace switch if required.
	Thermal switch S21 defective.	Check switch S21 and replace if required.
	Immersion heaters HR1 and HR2 defective.	Replace immersion heaters.
During standby operation, battery box does not warm up or maintain temperature.	ELEC HTR switch S18 defective.	Check switch contacts S18-2 and replace switch if required.
	Thermal switch S22 defective.	Check switch S22 and replace if required.
	Battery box strip heaters HR4 and HR5 defective.	Replace strip heaters.
During cold weather operation, battery box strip heaters are inoperative.	B and C contacts, or coil, of relay K24 defective.	Clean contacts or replace relay as required.
OPERATION switch S20 set to SINGLE UNIT position, and LOAD CONTACTOR switch S16 set to ON position, LOAD TERM ENERGIZED indicator lamp DS10 does not light.	Indicator lamp DS10 defective.	Check lamp and replace if required.
	Relay K19 defective.	Check relay K19 and replace if required.
	Load contactor switch S16 defective.	Check switch S16 and replace if required.
	C contacts or coil of relay K6 defective.	Clean contacts or replace relay as required.
	C contacts of relay K4 defective.	Clean contacts or replace relay as required.
120/208 VOLT CONN or 240/416 VOLT CONN indicator lamps DS13 or DS14 do not light during appropriate mode of operation.	Indicator lamps DS13 or DS14 defective.	Check lamps and replace if necessary.
	Link bars on reconnection panel not positioned properly.	Check positioning of link bars and reposition if required.
	Resistor R6 defective.	Check resistor R6 and replace if required.
SYNCHRONIZING indicator lamps DS11 and DS12 do not light or operate properly.	Indicator lamps DS11 or DS12 defective.	Check lamps and replace if required.
	Resistors R4 or R5 defective.	Check resistors R4 and R5 and replace if required.
	OPERATION switch S20 defective.	Check switch S20 and replace if required.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
SYNCHRONIZING indicator lamps DS11 and DS12 do not light or operate properly. (Cont)	FREQ SEL switch S30 defective.	Check switch contacts S30-2 and replace switch if required.
Poor automatic voltage regulation.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
	Voltage regulation automatic rheostat R13 defective.	Check rheostat R13 and replace if defective.
Unstable automatic voltage regulation.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
Poor manual voltage regulation.	Voltage regulation-manual transformer T7 defective.	Check transformer T7 and replace if required.
	Transformer-rectifier voltage regulator subassembly A1 defective.	Check subassembly A1 and replace if required.
Lube oil pressure gage M2 does not indicate.	Oil pressure gage defective.	Check gage M2 and replace if required.
	Lube oil pressure sending unit E1 defective.	Check sending unit E1 and replace if required.
	Gage not grounded.	Ground if necessary (case).
Fuel level gage M3 does not indicate.	Fuel level gage defective.	Check gage M3 and replace if required.
	Gage not grounded.	Ground if necessary (case).
	Fuel level sending unit E2 defective.	Check sending unit E2 and replace if required.
AUX FUEL PUMP switch S27 placed in ON position, auxiliary fuel pump B4 or B5 does not operate.	FUEL BRNG HTR switch S13 not in OFF position.	Place switch S13 to OFF position.
	Auxiliary fuel pump B4 or B5 defective.	Replace defective auxiliary fuel pump.
Fuel burning heater HR3 fails to operate.	FUEL BRNG HTR switch S13 defective.	Check switch S13 and replace if required.
	Heater fuel shut-off solenoid valve L2 does not open when energized.	Open heater shut-off valve.
	A contacts of relay K6 dirty or pitted.	Check contacts and clean if required.
Fuel burning heater HR3 fails to operate.	Fuel burning heater thermal switch S24 dirty.	Check switch S14 and replace if required.
	Electric fuel pump B3 defective.	Replace fuel pump.
	Burned out igniter.	Replace igniter.
	Burned out preheat resistor.	Replace preheat resistor.
	Defective fuel control valve.	Replace fuel control valve.
	Overheat switch defective.	Replace overheat switch.
	Flame detector switch defective.	Replace flame detector switch.
Heater overheats and stops burning.	Restriction in vent air flow. Defective fuel control valve.	Remove restriction. Replace fuel control valve.
Heater overheats but continues to burn.	Defective overheat switch in conjunction with other defect which causes overheating.	Replace overheat switch and then determine other cause of malfunctioning.
Heat output too low.	Defective fuel control valve. Low fuel pressure.	Replace fuel control valve. Correct condition in fuel system.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Heater smokes excessively or "bangs" upon starting.	Leaking fuel control valve.	Replace fuel control valve.
Blower will not stop when heater is turned off (after approximately 5 minutes).	Defective flame detector switch.	Replace flame detector switch.
Odor of fuel in ventilating air stream.	Leaking fuel connection at standpipe or fuel control valve.	Tighten fuel connections.
Blower runs but heater fails to ignite at low ambient temperature.	Defective heating element in fuel control valve. Defective igniter. Defective preheat resistor. Low voltage.	Replace fuel control valve. Replace igniter. Replace resistor. Check for 24 volts dc at terminals 3 and 8 of heater.
Heat exchanger becomes loaded up with soot and carbon when operating on diesel fuels.	Slow blower motor. High fuel rate. Restriction in exhaust. Too heavy grade of fuel for ambient condition.	Replace blower motor. Adjust fuel control valve. Remove restriction. Use correct grade of fuel. Clean heater by burning on gasoline.
Alternator temperature is extremely high.	Overload on alternator	Check alternator terminal voltage and current and reduce alternator load, if required.
	Restricted alternator ventilation.	Check for obstruction in air intake and discharge openings and remove if present.
	Short, ground, or open circuit in alternator windings.	Check alternator windings. If defective, replace alternator.
Alternator shaft does not turn freely.	Rotor shaft bent.	Replace alternator rotor.
	Rotor shaft bearing seized or worn.	Replace bearing.
Engine missing on all cylinders.	Incorrect grade of fuel.	Use correct grade of fuel.
	Water in fuel system.	Drain fuel system and refill with correct grade of fuel.
	Fuel injector nozzle valves sticking in body.	Clean fuel injectors.
	Leaking valves.	Regrind valves (overhaul level).
	Air cleaner dirty.	Check and service air cleaner if required.
	Valve clearance adjusted too close.	Readjust to correct clearance.
	Valve guides excessively worn.	Replace valve guides (overhaul level).
	Leaking head gasket.	Tighten cylinder head nuts to proper torque or replace gasket, if required.
	Warped or cracked cylinder head.	Replace cylinder head.
	Cracked cylinder block.	Replace (overhaul level).
Engine misses on one or two cylinders.	Air leaks in fuel lines.	Check for air leaks in fuel system and correct if required.
	Restricted fuel lines.	Check for and remove restriction.
	Fuel injectors out of adjustment.	Check and adjust fuel injectors if required.
	Leaky valves.	Regrind valves (overhaul level).
	Valve clearance incorrect.	Adjust valves to proper clearance.
	Fuel injector nozzle valve sticking in body.	Clean fuel injectors.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Engine misses on one or two cylinders. (Cont)	Piston rings and/or cylinder sleeves excessively worn.	Replace (overhaul level).
	Valve spring or spring retainer lock broken.	Replace spring or lock if required.
Loss of power.	Restricted air intake.	Check for inlet air restriction.
	Exhaust pipes or muffler restricted.	Clean or replace exhaust system.
	Incorrect grade of fuel.	Use correct grade of fuel.
	Plugged injector spray holes.	Clean injector spray holes.
	Throttle linkage sticky.	Lubricate linkages and eliminate any binding.
	Air cleaner dirty.	Check and service air cleaner if required.
	Engine blow-by or leakage.	Check for engine blow-by. If blow-by is excessive, new rings, pistons, or lines are needed (overhaul level).
	Leaky valves.	Regrind valves (overhaul level).
	Incorrect valve and injection timing.	Check valve and injector timing and adjustment and readjust if required.
	Worn cylinder sleeves.	Replace (overhaul level).
	Piston ring, broken, stuck, or excessively worn.	Replace (overhaul level).
	Valves and/or valve seats pitted or worn.	Regrind valves and seats (overhaul level).
Increasing of black or brown smoke in exhaust.	Leaky head gasket.	Tighten cylinder head nuts to proper torque or replace gasket if necessary.
	Leaky valves.	Regrind valves (overhaul level).
	Incorrect grade of fuel.	Use correct grade of fuel.
	Dirty fuel injectors.	Clean fuel injectors.
	Worn piston rings.	Replace (overhaul level).
	Fuel injection timing too early, usually accompanied with pre-ignition.	Check fuel injection timing.
	Fuel injection timing too late, usually accompanied with loss of power but smooth and quiet running engine.	Check fuel injection timing.
Engine knocking.	Loose or worn main bearings.	Replace (overhaul level).
	Loose or worn connecting rod bearings.	Replace (overhaul level).
	Loose piston pins.	Replace (overhaul level).
	Worn pistons and cylinder liners.	Replace (overhaul level).
	Tighten piston pins.	Replace (overhaul level).
	Overheated engine.	Allow engine to cool and then determine cause of overheating.
	Lack of lubricating oil.	Fill crankcase with proper grade and quantity of oil.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Engine knocking. (cont)	Loose flywheel.	Tighten in place. If worn excessively due to running loose, replace flywheel (overhaul level).
	Excessive end play in camshaft.	Adjust camshaft end thrust (overhaul level).
	Bent connecting rod.	Replace (overhaul level).
	Excessive valve clearance.	Adjust clearance to proper limits.
Fuel knocking.	Injector nozzle valve sticking due to dirt or corrosion.	Clean injectors.
	Injection nozzle spring broken.	Replace spring and close and readjust injector.
	Leaky cylinder head gasket.	Tighten cylinder head nuts to proper torque or replace gasket if necessary.
	Incorrect grade of fuel.	Use correct grade of fuel.
	Insufficient coolant.	Check radiator level and fill with coolant if required.
	Engine overloaded.	Reduce load.
Intermittent fuel knocking in more than one cylinder.	Incorrect grade of fuel oil	Use proper grade fuel.
	Injectors dirty or corroded.	Clean or replace as necessary.
	Water in fuel system.	Drain fuel system and refill with uncontaminated fuel.
Continuous and steady fuel knocking on all cylinders accompanied by dark smoky exhaust.	Incorrect grade of fuel.	Use proper grade of fuel.
Excessive fuel consumption accompanied by increased lubricating oil consumption due to oil dilution.	Sticking controls.	Lubricate linkages and eliminate any binding.
	Excessive idling of engine.	Do not idle engine for extended periods.
	Dirty air cleaner accompanied by loss of power.	Clean air cleaner.
	Engine overheating.	See engine overheating.
	Engine overcooling.	See engine overcooling.
Engine overheating.	Lack of cooling solution.	Refill cooling system and check for leakage.
	Fan belt not adjusted properly.	Check fan belt for required tension and adjust if required.
	Thermostat sticking.	Replace thermostat.
	Coating of calcium salts on inside of cooling system.	Clean cooling system.
	Dirt in radiator air passages.	Blow out with compressed air.
	Hoses deteriorated.	Replace hoses.
	Water pump not operating properly.	Replace pump.
	Exhaust pipes restricted. Usually accompanied by a hissing sound in the exhaust.	Clean pipes and remove restriction.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Engine overcooling.	Thermostat sticking open.	Replace thermostat.
Loss of coolant.	Leaks in radiator core.	Repair or replace as necessary.
	Loose hose connections.	Tighten connections.
	Radiator tubes clogged.	Clean or replace radiator.
	Water pump seals defective.	Replace (overhaul level).
	Loose freeze plugs in block.	Tighten or replace plugs.
	Cracked cylinder head or block.	Replace (overhaul level).
	Blown cylinder head gasket.	Replace gasket.
Excessive lube oil consumption.	Oil leaks at gaskets and parting surfaces.	Tighten or replace as necessary.
	Inferior grade of oil.	Use oil conforming to specification.
	Ring gaps too large.	Replace (overhaul level).
	Worn or broken piston rings.	Replace (overhaul level).
	Cylinder sleeves out of round or worn.	Replace (overhaul level).
	Main or connecting rod bearings worn.	Replace (overhaul level).
	Oil rings clogged.	Replace (overhaul level).
	Dirty air cleaner.	Check air cleaner and service if required.
	Engine blow-by or leakage.	Check for engine blow-by. If blow-by is excessive, new rings, pistons, or liners are needed (overhaul level).
Bearing failures.	Continuous engine overspeeding.	Operate at governed speed.
	Lack of lubrication.	Keep oil at "H" mark on gage.
	Inferior grade of oil.	Use oil conforming to specification.
	Bent connecting rod.	Replace (overhaul level).
	Crankshaft rough or out of round.	Replace (overhaul level).
	Restricted oil passages.	Clean oil lines and passages.
	Bearing loose.	Replace (overhaul level).
	Dirty oil.	Service filter elements regularly.
Rapid cylinder or piston wear.	Breather and air cleaner not properly serviced.	Clean breather and air cleaner regularly.
	Inferior grade of oil.	Use oil conforming to specification.
	Lack of lubrication.	Keep oil at "H" mark on gage.
	Dirty oil.	Service filter elements regularly.
	Piston rings not fitted properly.	Replace (overhaul level).
	Cold operation of engine.	Check thermostat and replace if necessary.

TABLE 6-1. TROUBLE SHOOTING TABLE (Continued)

Trouble	Probable Cause	Remedy
Valve sticking.	Incorrect valve clearance.	Adjust clearance.
	Valve springs weak or broken.	Replace springs.
	Valve stems or guides scored or dirty.	Clean, polish, or replace valves.
Burned valves or valve seats.	Valve clearance set too close.	Adjust valves to proper clearance.
	Weak valve springs.	Replace springs.
	Excessive carbon deposites.	Remove carbon deposits.
	Camshaft not timed correctly.	Retime camshaft.

b. Assemble drive belt on water pump pulley and water pump drive pulley.

c. Turn water pump to low point of its eccentric and install in place in cylinder block. Secure lightly with capscrews and lock-washers.

d. Insert a large screw driver in holes provided in water pump and turn water pump on its eccentric counter-clockwise to tighten belt.

e. Tighten capscrews on water pump.

6-18. INSTALLATION OF FAN AND FAN PULLEY. To install fan and fan pulley, proceed as follows:

a. Assemble fan pulley to water pump.

CAUTION

Avoid stretching the belts. Loosen the adjusting screw until the belts go into position.

b. Tighten adjusting screw to get proper tension on drive belts and tighten hub. Pack fan hub bearings with a good grade ball-bearing grease.

c. Assemble fan and dirt exclusion plate to fan hub.

6-19. FAN BELT ADJUSTMENT. Adjust fan belt tension as described in paragraph 5-33.

6-20. LUBE OIL COOLER.

6-21. REMOVAL. To remove lube oil cooler, proceed as follows:

a. Remove water connections.

b. Remove capscrews securing cooler housing to cylinder block.

c. Loosen oil cooler head capscrews and remove oil cooler head. (On some models, oil cooler head and housing are cast as one unit.)

d. Screw two 10/32 inch capscrews into tapped holes provided in the element and pull element from housing. Remove "O" rings and discard.

6-22. CLEANING ELEMENT. To clean element, proceed as follows:

a. Clean element with solvent, Federal Specification P-S-661 until oil film and sludge are dissolved.

CAUTION

Do not use solvent that will harm copper. Do not use a mechanical cleaning method such as scraping.

b. Blow out bundle thoroughly with compressed air.

c. Clean housing and head, if used, with solvent. Blow out with compressed air.

6-23. INSTALLATION. To install lube oil cleaner, proceed as follows:

a. Replace head to housing using retainer and new "O" ring lubricated with ball bearing grease. If housing and head are one integral casting, install lubricated "O" ring at bottom of housing.

b. Push element into housing by hand aligning index marks on housing and element.

c. Press a new "O" ring around top of element using a wooden block to exert equal pressure on entire "O" ring circumference.

d. Install steel retainer ring over "O" ring.

e. Install new gasket and secure assembled lube cooler to cylinder block.

6-24. FUEL PUMP.

6-25. REMOVAL. To remove the fuel pump, proceed as follows:

a. Remove fuel line connecting fuel pump and inlet manifold.

b. Disconnect fuel pump inlet and drain lines.

c. Remove four stud nuts or capscrews, lockwashers, and flatwashers holding pump to gear box, and remove fuel pump from engine. Remove the rubber coupling from drive unit.

6-26. INSTALLATION. To install fuel pump, proceed as follows:

a. Install fuel pump to gear box with new gasket and rubber buffer in position. Place flatwashers, lockwashers, and nuts over the four studs and tighten.

b. Connect pump drain and inlet-to-fuel-tank lines.

c. Install fuel line from pump to fuel inlet manifold.

6-27. ADJUSTMENT. Check fuel rate of installed fuel pump and adjust rate, if required.

6-28. FUEL INJECTORS.

6-29. REMOVAL. To remove fuel injectors, proceed as follows:

a. Remove the three capscrews and washers from rocker cover and lift it from the rocker housing.

b. Remove fuel inlet and drain lines to injector connections.

c. Remove fuel inlet and drain connections from the injector body.

d. Loosen injector locknut and unscrew adjusting screw until push tube can be disengaged.

e. Disengage push tube and tip back rocker lever until injector can be removed.

f. Remove hold-down capscrews and lift injector from the cylinder head.

CAUTION

Do not bruise the injector tip.

6-30. INSTALLATION. To install fuel injectors, proceed as follows:

a. Make sure same type injectors are put in as taken out.

b. Wrap a clean cloth around a wooden stick and clean-out injector sleeve. Injector sleeves are made of copper and are closely machined to seal injector cup.

CAUTION

Never use a screw driver or any metal object when cleaning injector sleeve.

c. Place injector in its proper position in cylinder head, being very careful not to hit or damage the injector tip.

d. Start, but do not tighten, the injector hold-down capscrews.

e. In order to align injectors before tightening hold-down capscrews, screw in inlet and drain connections about three turns.

f. Oil injector hold-down capscrews and tighten to 12 to 14 foot-pounds with a torque wrench.

CAUTION

Injector hold-down capscrews contain a nylon insert that acts as a lock. These capscrews may be reused 5 to 10 times before the effectiveness of the insert is impaired. Nylock capscrews should be tightened to 12 to 14 foot-pounds with a torque wrench. Excessive tightening will distort the valve seats and will crack the cylinder head.

g. Tighten inlet and drain connections to 20 to 25 foot-pounds with torque wrench.

h. Assemble injector rocker lever to injector push tube.

i. Adjust injectors and valves described in paragraph 5-31.

j. Install rocker-lever cover.

6-31. CYLINDER HEAD.

6-32. REMOVAL. Removal of the cylinder head first requires removal of the intake and exhaust manifolds, water manifold, rocker housing covers and housing, and fuel injectors and connections.

6-33. REMOVAL OF INTAKE AND EXHAUST MANIFOLDS. To remove intake and exhaust manifolds, remove the capscrews and lockwashers at each intake and exhaust port and lift intake and exhaust manifolds from engine.

6-34. REMOVAL OF ROCKER HOUSING COVERS AND HOUSING. To remove rocker housing covers and housing, proceed as follows:

a. Remove rocker housing covers by taking out the three capscrews holding each cover to housing.

b. Remove lubricating oil pipe cap and gasket.

c. Remove the seven capscrews from each rocker housing and lift separately from engine by grasping end of each injector rocker.

d. Remove push rods by lifting them from their sockets.

6-35. REMOVAL OF FUEL INJECTORS AND CONNECTIONS. To remove fuel injectors and connectors, follow the removal procedure described in paragraph 6-29. After the injectors and connections are removed, place injectors and connections in order so that they may be replaced together.

6-36. CYLINDER HEAD. To remove cylinder head, remove cylinder head capscrews with a heavy duty socket wrench. Lift cylinder head from engine.

CAUTION

Do not let machined surfaces become scratched or marred in any way.

6-37. INSTALLATION OF CYLINDER HEAD. To install cylinder head, proceed as follows:

a. Make sure that breather hole, located at top of cylinder head between center stud holes, is plugged with 1/8 inch pipe plug.

b. Wipe mating surfaces of cylinder block and cylinder head clean.

c. Place grommet retainers in water passages in block, small end up.

d. Lay gasket on flat surface, and press grommets into place by hand.

NOTE

If water hole in block is eroded, install retainer, then rubber grommet. If water hole in head is eroded, install rubber grommet, then retainer with small end down.

CAUTION

Avoid all contact between grommet and fuel or lube oil to prevent damage due to swelling.

e. Install head gasket, stamped word TOP to top, over oil pipes. Be careful not to dislodge grommets as gasket is lowered over grommet retainers.

f. Examine oil pipe bore on milled surface of cylinder head for counterbore. If counterbore occurs at top surface of head, install washer on oil pipe after cylinder heads have been placed on block.

g. Oil cylinder head capscrews and tighten each slightly in the correct order as shown in figure 6-1. Continue tightening in rotation and in 100 foot-pound steps with a torque wrench until all capscrews have been tightened to 430 to 450 foot-pounds.

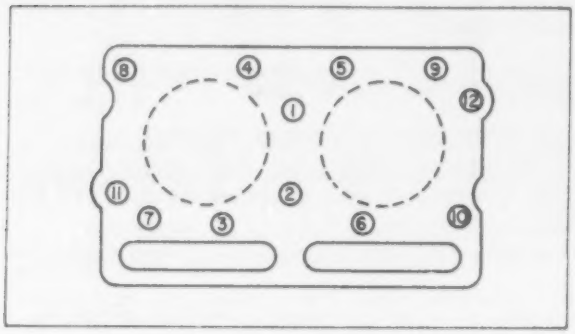


Figure 6-1. Cylinder Head Tightening Sequence

6-38. INSTALLATION OF FUEL INJECTORS AND CONNECTIONNS. To install fuel injectors and connections, follow the installation procedures described in paragraph 6-30.

6-39. INSTALLATION OF PUSH RODS. To install the push rods, insert push rods for injector, intake and exhaust valves for each cylinder into sockets of cam follower levers. Injector push rod is largest and goes in middle of socket.

6-40. CROSS HEADS. Assemble cross heads with adjusting screw toward water manifold. For cross head adjustment, refer to paragraph 5-31.

6-41. INSTALLATION OF ROCKER ARM HOUSING. To install rocker arm housing, proceed as follows:

a. Install a new rocker housing gasket over capscrews to cylinder heads.

b. Loosen locknuts and back off rocker arm adjusting screws two or three turns. While holding rocker arms in place, assemble each housing in place with ball ends of rocker arms fitting into their respective push rod sockets.

c. Place a new gasket on each lubricating oil pipe and tighten down caps.

d. Insert and tighten capscrews to 65 foot-pounds in sequence shown in figure 6-2.

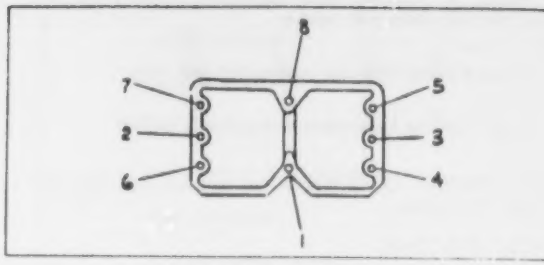


Figure 6-2. Rocker Housing Tightening Sequence

6-42. INSTALLATION OF ROCKER HOUSING COVERS. install rocker housing covers, proceed as follows:

a. Install rocker housing covers to rocker housing and sec with the three capscrews and washers.

b. Assemble breather (if used) to rocker housing cover.

6-43. ADJUSTMENTS OF VALVES AND FUEL INJ TORS. Adjust valves and fuel injectors as described in paragra 5-31.

6-44. INSTALLATION OF WATER MANIFOLD. To inst water manifold, cement a new gasket to each manifold foot a secure manifold to cylinder heads.

6-45. INSTALLATION OF INTAKE AND EXHAUST MA FOLDS. To install intake and exhaust manifolds, proceed follows:

a. Install intake and exhaust manifolds with new gaskets.

b. Tighten capscrews securly, beginning at center a working toward the ends.

CAUTION

Keep exposed outlets covered until connected to mating part.

6-46. FUEL BURNING HEATER

6-47. REMOVAL. To remove fuel burning heater from engin proceed as follows:

a. Disconnect wiring leads from heater.

b. Remove hose and adapter clamp from heater outlets.

c. Remove four capscrews that attach heater assembl brackets to mounting beams.

d. Remove heater from mounting beams.

6-48. PARTS REPLACEMENT. The following paragraphs giv the procedures for the replacement of major parts of the fu burning heater that may be done by maintenance personnel.

6-49. REMOVAL OF GUARD ASSEMBLY. To remove guard assembly, release two Dzus fasteners and lift guard assembly off heater.

6-50. REMOVAL OF BLOWER ASSEMBLY. To remove blower assembly, proceed as follows:

a. Disconnect blower lead from terminal No. 6 of terminal strip.

b. Remove blower by loosening four mounting screws on the end of heater housing. Turn blower counterclockwise to free bayonet slots and pull it straight off housing.

c. Remove louver plate from blower inlet by removing three screws.

6-51. REMOVAL OF FUEL CONTROL VALVE. To remove fuel control valve, proceed as follows:

a. Loosen compression fittings at both ends of short fuel line between fuel control valve and standpipe and remove the fuel line.

b. Disconnect the fuel control valve leads from terminals No. 5 and 8 of the terminal strip, and terminal No. 30 of overheat switch. Remove fuel control valve by removing four screws, and remove the elbow from the valve.

c. Remove sleeve from solenoid leads, or tape in position to prevent loss.

6-52. REMOVAL OF PREHEAT RESISTOR. To remove preheat resistor, proceed as follows:

a. Loosen nut of igniter terminal.

b. Disconnect leads of preheat resistor from terminals 4, 7 and 8 of terminal strip and slide the resistor off of standpipe.

6-53. REMOVAL OF IGNITER. To remove igniter, proceed as follows:

a. Remove igniter, using a 13/16-inch deep socket. After igniter threads are clear, draw it out of the hatch cover by hand.

b. When replacing the igniter, start the threads by hand then tighten with a wrench.

6-54. REMOVAL OF FLAME DETECTOR SWITCH. To remove flame detector switch, proceed as follows:

a. Remove five screws which attach the flame detector switch cable to switch.

b. Using an open end wrench, back off compression nut of flame detector switch until it clears threads of boss on heat exchanger. Pull switch straight out of heat exchanger, being careful not to bend tube, since it contains a ceramic (or quartz) rod which is easily broken.

c. Disconnect leads of flame detection switch cable from terminal strip and remove cable as one part.

6-55. ADJUSTMENT OF FLAME DETECTOR SWITCH. Refer to paragraph 5-30 if adjustment of flame detector switch is required.

6-56. REMOVAL OF OVERHEAT SWITCH. To remove overheat switch, proceed as follows:

a. Disconnect lead of overheat switch from terminal No. 9 of terminal strip.

b. Remove two mounting screws from weld nuts in heater housing and lift off switch.

c. Replace nuts and washers on switch terminals after removing wire.

6-57. INSTALLATION. To install the major parts of the heater, reassemble the parts in the reverse order of disassembly.

SECTION VII

CALIBRATION

7-1. CALIBRATION CHECK OF INSTRUMENTS.

7-2. To calibrate the various meters and gages of the engine-generator set, proceed as follows:

a. Select accurate test instrument which is same type as suspect instrument.

b. Observe sample reading from suspect instrument and then disconnect it.

c. Connect test instrument in same manner that suspect instrument was installed.

d. Under same conditions, take test reading.

e. If suspect instrument reading differs, replace it.

PART 2

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

SECTION I

INTRODUCTION

1-1. DELETED

1-2. DELETED

1-3. DELETED

DELETED

1-5. DELETED

1-6. DELETED

1-7. DELETED

1-8. DIFFERENCE DATA SHEETS.

1-9. Sections I, II, and III of this technical manual contain overhaul and test instructions for Skid-Mounted Diesel Engine-Generator Set, USAF Model MB16. Overhaul and test instructions for additional models will be provided in Section IV by the use of Difference Data Sheets.

1-10. Overhaul instructions and test procedures for models to be included in Section IV will be the same as those given in Sections II and III, except for the Difference Data sheets.

PAGES 1-3 and 1-4 are

DELETED

SECTION II

OVERHAUL INSTRUCTIONS

2-1. GENERAL.

2-2. The Skid-Mounted Diesel Engine-Generator Set consists of a diesel engine-generator set assembly as illustrated in figure 1-1, part 1. The following paragraphs provide overhaul instructions for each of the subassemblies of this major assembly.

2-2A. MISCELLANEOUS CABLE ASSEMBLY.

2-2B. SPECIAL TOOLS. No special tools are required for overhauling the miscellaneous cable assembly.

2-2C. DISASSEMBLY. Disassembly of the miscellaneous cable assembly consists of disconnecting and removing the cables listed in figure 1-1A.

2-2D. CLEANING.

a. Remove dust or dirt by blowing with low pressure filtered compressed air.

b. Clean with soft cloth moistened with chlorothene N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered low pressure compressed air.

2-2E. INSPECTION.

a. Inspect wiring for signs of overheating and charred or frayed insulation.

b. Assure the integrity of crimp type lugs, by inspecting for corrosion and loose or broken terminals.

2-2F. TESTING. Test individual wires for continuity, utilizing an ohmmeter.

2-2G. REPAIR OR REPLACEMENT. Repair or replace broken or damaged wires and terminal lugs as required.

2-2H. LUBRICATION. No lubrication required.

2-2J. REASSEMBLY. Reassembly consists of installing and connecting cables listed in figure 1-1A.

2-3. DIESEL ENGINE-GENERATOR SET ASSEMBLY.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.

2-4. SPECIAL TOOLS. No special tools are required for overhaul of the diesel engine-generator set.

2-5. DISASSEMBLY. Disassembly of the diesel engine-generator set consists of the removal of major subassemblies and then the disassembly of these subassemblies. It should be noted that although complete disassembly instructions are provided in this section, disassembly for purposes of repair should be made only as far as the repair is necessary. Remove the major subassemblies in accordance with figure 2-1 and the following procedures.

Presence of a new part in the applicable kit eliminates the necessity of cleaning, inspecting, or reworking the equivalent used part removed from the assembly being repaired. Residue from kits and removed parts in this category shall be administratively condemned. The instructions which follow cover removed parts not supplied in kits and kitted parts (if any) which require cleaning, inspecting, or testing prior to installation.

a. Remove the components of the housing assembly in accordance with the instructions provided in paragraph 2-14.

b. Disconnect and tag all wire leads and cables between the control box assembly and the unit before removing the control box assembly.

c. Disconnect battery cables before removing batteries or battery box.

NOTE

Always disconnect ground battery cable first and reconnect it last to prevent accidental shorting when removing other battery cable.

d. Two or three persons are required to remove components of the radiator and shutter assembly. (Refer to paragraph 2-135).

e. Remove the components of the winterization assembly in accordance with the instructions provided in paragraph 2-146. Two persons are required for removal of the fuel burning heater

f. Remove the components of the fuel system installation in accordance with the instructions provided in paragraph 2-171. Tag fuel lines upon removal so that they may be replaced correctly.

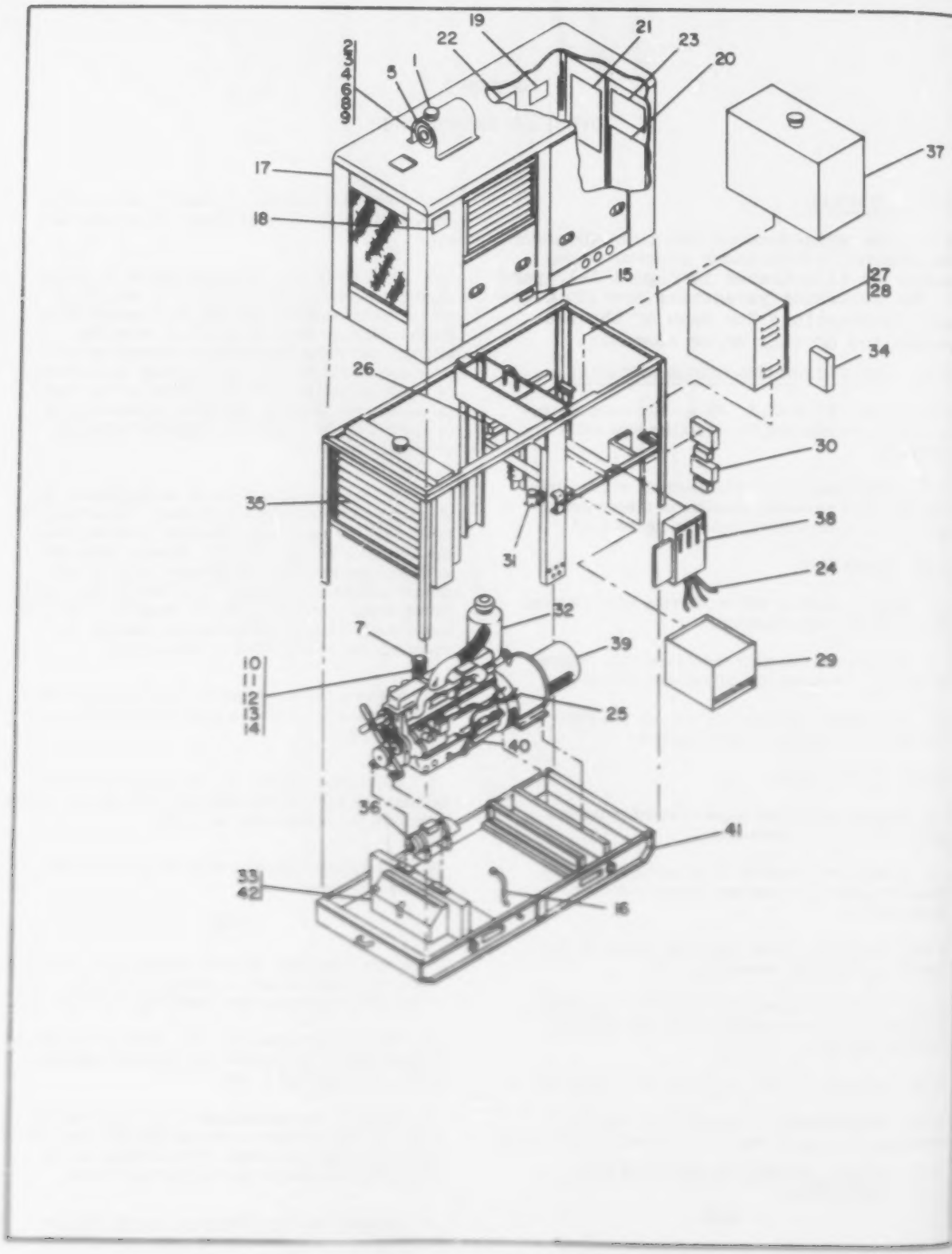


Figure 2-1. Engine-Generator Set, Major Assemblies

Legend To Figure 2-1

1. Rain Shield
2. Muffler Guard
3. Machine Screw
4. Lockwasher
5. Exhaust Muffler
6. Clamp
7. Clamp
8. Mounting Bracket
9. Bracket
10. Exhaust Pipe
11. Hex. Head Capscrew
12. Lockwasher
13. Plain Nut Hex.
14. Exhaust Gasket
15. Electrical Receptacle Connector
16. Oil Drain Assembly
17. Housing Assembly
18. Identification Plate
19. Fuel System Decalcomania
20. Lamination Wiring Diagram
21. Operating Instructions Decalcomania
22. Winterization Decalcomania
23. Warning Plate
24. Load and Reconnection Harness
25. Engine and Generator Harness
26. Fuel Level Control
27. Control Box Assembly
28. Bolt
29. Battery Box Assembly
30. Contactor Installation
31. Electrical Solenoid
32. Air Cleaner Installation
33. Tool Box Assembly
34. Governor Control Box
35. Radiator and Shutter Assembly
36. Winterization Installation
37. Fuel System Installation
38. Load and Reconnection Assembly
39. Generator
40. Diesel Engine Assembly
41. Chassis Assembly
42. Auxiliary Fuel Line

g. Remove all leads between load and reconnection panel assembly and alternating current generator before removing these assemblies.

h. Use proper lifting equipment when removing the engine from the skid base.

2-6. CLEANING.

NOTE

Instructions for cleaning the individual components of the major assemblies removed in paragraph 2-5 are given in the paragraphs describing the overhaul of these assemblies.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint-free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661, to come in contact with electrical parts.

c. Clean electrical parts with a clean soft brush moistened with trichlorethylene, Military Specification MIL-T-7003.

WARNING

When using trichlorethylene, Military Specification MIL-T-7003, make sure there is adequate ventilation, as the fumes are toxic. Avoid prolonged exposure of bare skin to fumes.

d. Clean sludge from oil drain assembly with dry cleaning solvent, Federal Specification P-S-661.

2-7. INSPECTION. Instructions for inspecting the individual components of the major assemblies removed in paragraph 2-5 are given in the paragraphs describing the overhaul of those assemblies.

2-8. TESTING. Instructions for testing the individual components of the major assemblies removed in paragraph 2-5 are given in paragraphs describing the overhaul of those assemblies.

2-9. REPAIR OR REPLACEMENT. Instructions for repair or replacement of the components of the major assemblies removed in paragraph 2-5 are given in the paragraphs describing the overhaul of those assemblies. Refer to figure 2-1A for wiring harness and cutting list.

2-10. LUBRICATION. Instructions for lubricating the individual components of the major assemblies removed in paragraph 2-5 are given in the paragraphs describing the overhaul of those assemblies.

LIST OF MATERIALS					
QTY REQD	NOMENCLATURE	CODE IDENT	IDENTIFYING NO.	SPECIFICATION	ITEM NO.
1	RELAY, FIELD FLASH	98749	64B41405		25
A/R	SOLDER		MIL-S-6872		24
350	TY-RAP, SELF-CLINCHING		MS17821-1-9		23
40"	INSULATION, ELECTRICAL, #16 AWG	71124	MIL-I-631		22
1	CONNECTOR, ELECTRICAL		MS3106RM-6S		21
1	CONNECTOR, ELECTRICAL		MS3106R20-29S		20
1	CONNECTOR, ELECTRICAL		MS3108E32-7S		19
1	CONNECTOR, ELECTRICAL		MS3108E36-7S		18
3	INSULATOR, DOUBLE, FEMALE	13445	CH30204		17
1	INSULATOR, SINGLE, FEMALE	13445	CH30202		16
7	TERMINAL, FEMALE	13445	CH31100		15
3	INSULATOR	77060	5297052		14A
3	CONTACT	77060	2965639		14
3	SHELL	77060	5297053		13A
1	LUG, CRIMP STYLE, INSULATED	59730	RF9741		13
1	LUG, CRIMP STYLE, INSULATED		MS25036-158		12
1	LUG, CRIMP STYLE, INSULATED		MS25036-157		11
12	LUG, CRIMP STYLE, INSULATED		MS25036-155		10
3	LUG, CRIMP STYLE, INSULATED		MS25036-109		9
16	LUG, CRIMP STYLE, INSULATED		MS25036-154		8
14	LUG, CRIMP STYLE, INSULATED		MS25036-108		7
91	LUG, CRIMP STYLE, INSULATED		MS25036-153		6
17	LUG, CRIMP STYLE, INSULATED		MS25036-106		5
2	LUG, CRIMP STYLE, INSULATED		MS25036-152		4
600"	WIRE, 600V, AIRCRAFT, #16 AWG		MB1044/2-16-9	MIL-W-81044/2	3
114"	WIRE, 600V, AIRCRAFT, #14 AWG		MB1044/2-14-9	" " "	2
16"	WIRE, 600V, AIRCRAFT, #12 AWG		MB1044/2-12-9	" " "	1

Figure 16. End Bearing Harness and Cutting List (Sheet 2 of 2)

-11. REASSEMBLY. Refer to paragraph 2-551 for reassembly procedures.

-12. HOUSING AND SHUTTER ASSEMBLY.

-13. SPECIAL TOOLS. No special tools are required.

-14. DISASSEMBLY. Disassemble the housing assembly by following the sequence of index numbers in figure 2-2. Disassemble the side shutter assemblies in accordance with the index numbers assigned to figure 2-3.

-15. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint-free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

c. Hard encrustations on housing may be scrubbed off with a bristle brush that has been dipped in cleaning solvent.

d. Rinse entire housing in clean solvent to remove all remaining residue.

e. When housing is clean, dry with compressed air.

-16. INSPECTION. Inspect doors and hinges for excessive wear. Inspect hardware for rust and corrosion.

-17. TESTING. Test the action and temperature response of the side door shutters in accordance with the procedures given in paragraph 3-142. The side door shutters should begin to open at an ambient temperature of 55°F and should be fully opened at temperature of 80°F.

-18. REPAIR OR REPLACEMENT.

a. Refinish any chipped, peeled, or blistered paint in accordance with Military Specification MIL-T-704.

b. Clean up and blend in any burrs, minor galling, dents, or scratches with crocus cloth (Federal Specification P-C-458).

c. Sheet metal repairs must be accomplished by qualified personnel who are familiar with basic shop requirements.

d. To repair hinges, first determine whether looseness is caused by worn pins or rivets. Replace pins or hinges, as required.

e. LUBRICATION. Apply a thin film of lubricant, Dow Corning No. 44, or equivalent, to hinges.

2-20. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-21. CONTROL BOX ASSEMBLY.

2-22. SPECIAL TOOLS. No special tools are required for overhaul of the control box assembly.

2-23. DISASSEMBLY. Disassemble the control box assembly in accordance with the sequence of index numbers assigned to figure 2-4. Remove and tag wire leads to the voltage regulator subassembly, and remove the voltage regulator assembly. (Refer to paragraph 2-54 for voltage regulator assembly overhaul procedures). Do not remove the harness assembly from the control box unless visual checks or continuity checks indicate that replacement is necessary. Tag leads of all removed components and note polarity of capacitors.

2-24. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint-free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

c. Clean electrical parts with a soft bristle brush moistened with Trichlorethylene, Military Specification MIL-T-7003.

WARNING

When using trichlorethylene, Military Specification MIL-T-7003, make sure that there is adequate ventilation, as fumes are toxic. Avoid prolonged exposure of bare skin to fumes.

2-25. INSPECTION.

a. Inspect all electrical parts and wiring for signs of overheat, and charred or frayed insulation.

b. Inspect contacts of switches, relays, and circuit breakers for signs of pitting and carbon deposits.

c. Inspect fuse elements to determine whether fuses have blown.

d. Check switches for freedom of action.

e. Inspect meters and gages for cracked glass.

f. Inspect hardware for stripped threads.

2-26. TESTING. Test components of the control box assembly as indicated in the following subparagraphs. Refer to Section III for test procedure for the entire control box assembly.

2-26A. GENERAL.

a. Perform a continuity test of all control box harness wiring in accordance with the wiring diagram given in figure 3-3.

b. Make continuity tests of all switches.

c. Test resistors and capacitors for proper value.

d. Test transformers for open or shorted windings.

e. Test lamps at rated voltage and current.

f. Test all meters and indicators in accordance with procedures given in Section III.

2-26B. REPAIR OR REPLACEMENT. Repair any item noted defective during inspection or test. Replace item if repair cannot be accomplished. Refer to figure 2-4A for wiring harness and cutting list.

2-26C. LUBRICATION. No lubrication required.

2-26D. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-27. LOAD SHARING ASSEMBLY.

2-28. SPECIAL TOOLS. No special tools required.

2-29. DISASSEMBLY. Disassemble the load sharing assembly by following the sequence of index numbers in figure 3-5.

2-30. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorothene, N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered, low pressure, compressed air.

2-31. INSPECTION.

a. Inspect all electrical parts and wiring for signs of overheating and charred and frayed insulation.

b. Inspect transformers for signs of insulation deterioration, physical damage or loose terminals.

2-32. TESTING. Test the load sharing assembly as follows:

a. Connect external test circuit to load assembly as shown in figure 3-6.

NOTE

Test equipment not supplied.

b. Refer to figures 2-7 and 2-8, the schematic and wiring diagram for the load sharing assembly while performing test.

c. Set load sharing rheostat R3 to full CCW position.

d. Adjust input variac until input voltmeter (terminals 1 and 2) reads 120 Vac.

e. Output voltmeter should read 0 Vdc.

f. Set load sharing rheostat R3 to full CW positi

g. Output voltmeter should read greater than 10 Vdc.

NOTE

If output cannot be achieved, black wires on transformer T2 may require interchanging.

h. If load sharing assembly proves erratic, refe to schematic, figure 2-7 and wiring diagram, figu 2-8 and check individual components for proper values. Perform a continuity test of all wiring. Test transformers for open or shorted windings.

2-33. REPAIR OR REPLACEMENT. Repair any item noted defective during inspection or test. Replace entire assembly if repair cannot be accomplished. Repeat test after repair or replacement. Refer to figure 2-4A for wiring harness and cutti list.

2-34. LUBRICATION. No lubrication required.

2-35. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-36. KILOWATT TRANSDUCER ASSEMBLY.

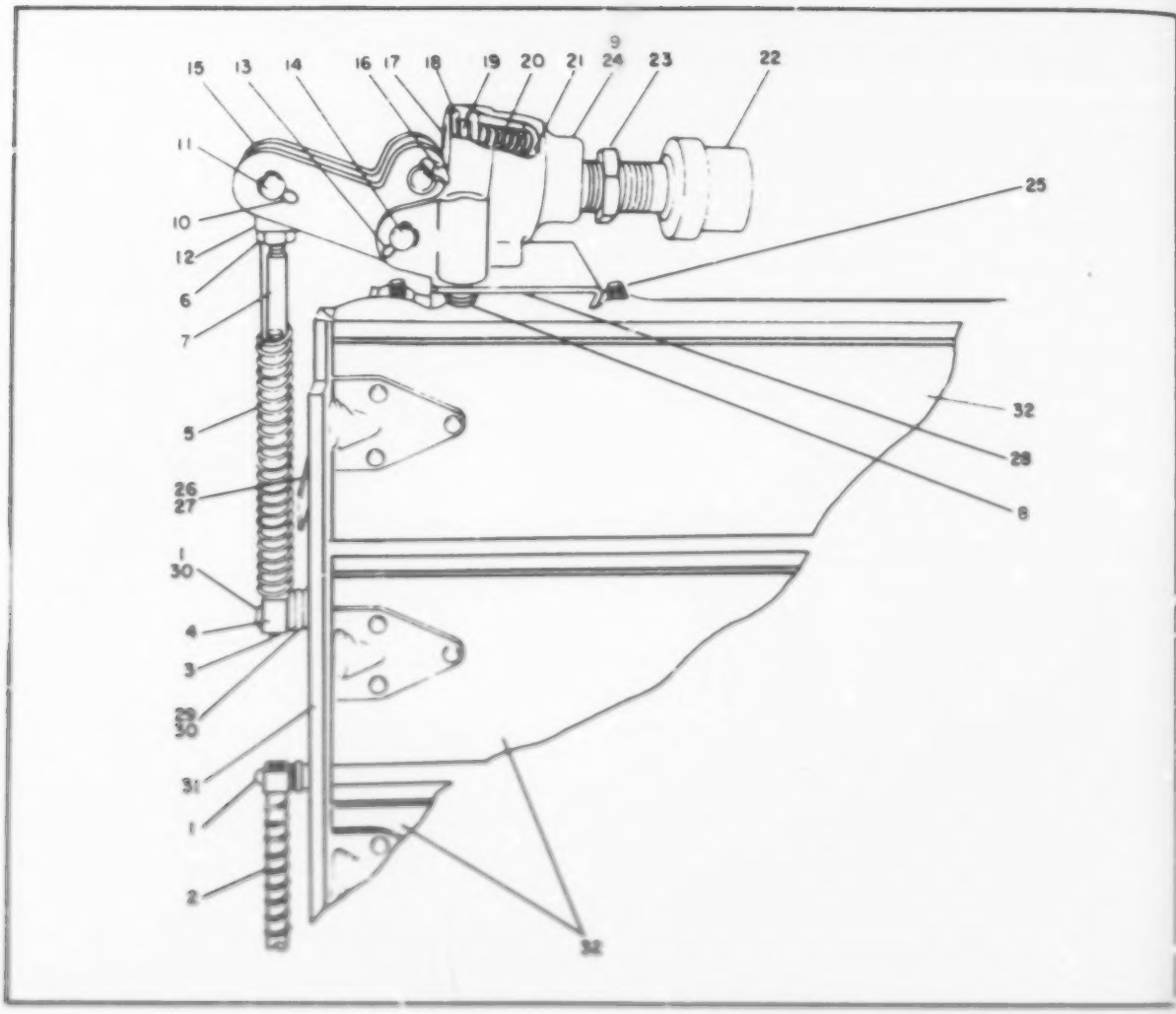
2-37. SPECIAL TOOLS. No special tools requi

2-38. DISASSEMBLY. Reassemble the kilowatt transducer assembly by following the sequence of index numbers in figure -8.

2-39. CLEANING.

a. Remove surface dirt or dust by wiping with lint free cloth moistened with chlorothene N.U. Federal Specification O-T-620C.

b. Air dry with low pressure, filtered, compressed air.



1. Plain Stud
2. Spring
3. Cotter Pin
4. Block
5. Spring
6. Nut
7. Rod
8. Screw
9. Control Assembly
10. Cotter Pin
11. Pin
12. Block
13. Retaining Ring
14. Pin
15. Lever
16. Plunger and Pin Assy.
17. Retaining Ring
18. Spring Seat
19. Washer
20. Spring
21. Spring Seat
22. Power Element
23. Nut
24. Housing
25. Screw
26. Guide
27. Screw
28. Bracket
29. Washer
30. Stud
31. Control Gas
32. Shutter

2-40. INSPECTION.

a. Inspect for physical damage.

b. Examine electrical connector for damage.

c. Inspect harness assembly for signs of charred or frayed insulation or loose connections.

2-41. TESTING. The following test consists of a check at 0, 33-1/3, 66-2/3 and 100% indication of the transducer. Test the kilowatt transducer assembly as follows:

a. Connect external test circuit as shown in figure 2-10.

NOTE

Test equipment not supplied.

b. Raise input voltage to 120 Vac line to neutral.

c. Set calibration adjustment fully CCW on transducer.

d. Set zero adjustment on transducer for zero indication on kilowatt meter.

e. With all switches closed and resistors set for proper current, set calibration adjustment on transducer for 100% indication.

f. Open all switches and reset zero adjustment, if required.

g. Close all switches. Indicator should read 100%.

h. Each switch should reduce the indication by 1/3 when opened.

i. Any two switches opened should reduce the indication by 2/3.

j. All switches opened should produce zero indication.

k. If kilowatt transducer assembly proves erratic, refer to schematic diagram, figure 3-11 and wiring diagram, figure 2-12 and check components. Perform a continuity test of all wiring. Test transformers for open or shorted windings. Check electrical connector for shorted or open circuits.

2-42. REPAIR OR REPLACEMENT. Repair any item noted defective during inspection or test. The kilowatt meter converter must be replaced if defective. Replace entire assembly if repair cannot be accomplished. Repeat test after repair or replacement. Refer to figure 2-12A for wire cutting list.

2-43. LUBRICATION. No lubrication required.

2-44. REASSEMBLY. Accomplish in the reverse order of disassembly.

2-45. RELAY PANEL ASSEMBLY.

2-46. SPECIAL TOOLS. No special tools required.

2-47. DISASSEMBLY. Disassemble the relay panel assembly by following the sequence of index numbers in figure 2-13.

2-48. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure, filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorethene N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered, low pressure, compressed air.

2-49. INSPECTION.

a. Inspect all electrical parts and wiring for signs of overheating and charred or frayed insulation.

b. Inspect contacts of relay for signs of pitting and carbon deposits.

2-50. TESTING. The following procedure covers the calibration of the time delay section (K3/K23) section of the relay assembly. It also tests relay operation and circuit continuity of the control relay section.

NOTE

The test must be performed with the control relays and statiswitches plugged into the assembly.

a. TIME DELAY SECTION SETUP PROCEDURE.

1. Connect relay panel assembly to the test set as shown in figure 2-14.

2. Set test switches in initial positions as follows:

(a) Switch A, position 1

(b) S1 - ON

(c) S2 - OFF

(d) S3 - OFF

(e) S4 - OFF

(f) S5 - OFF

(g) Indicator lamps DS2 and DS6 should be light.

3. Close switch S2. Count time from instant S2 is closed to instant DS1 and DS3 lights.

NOTE

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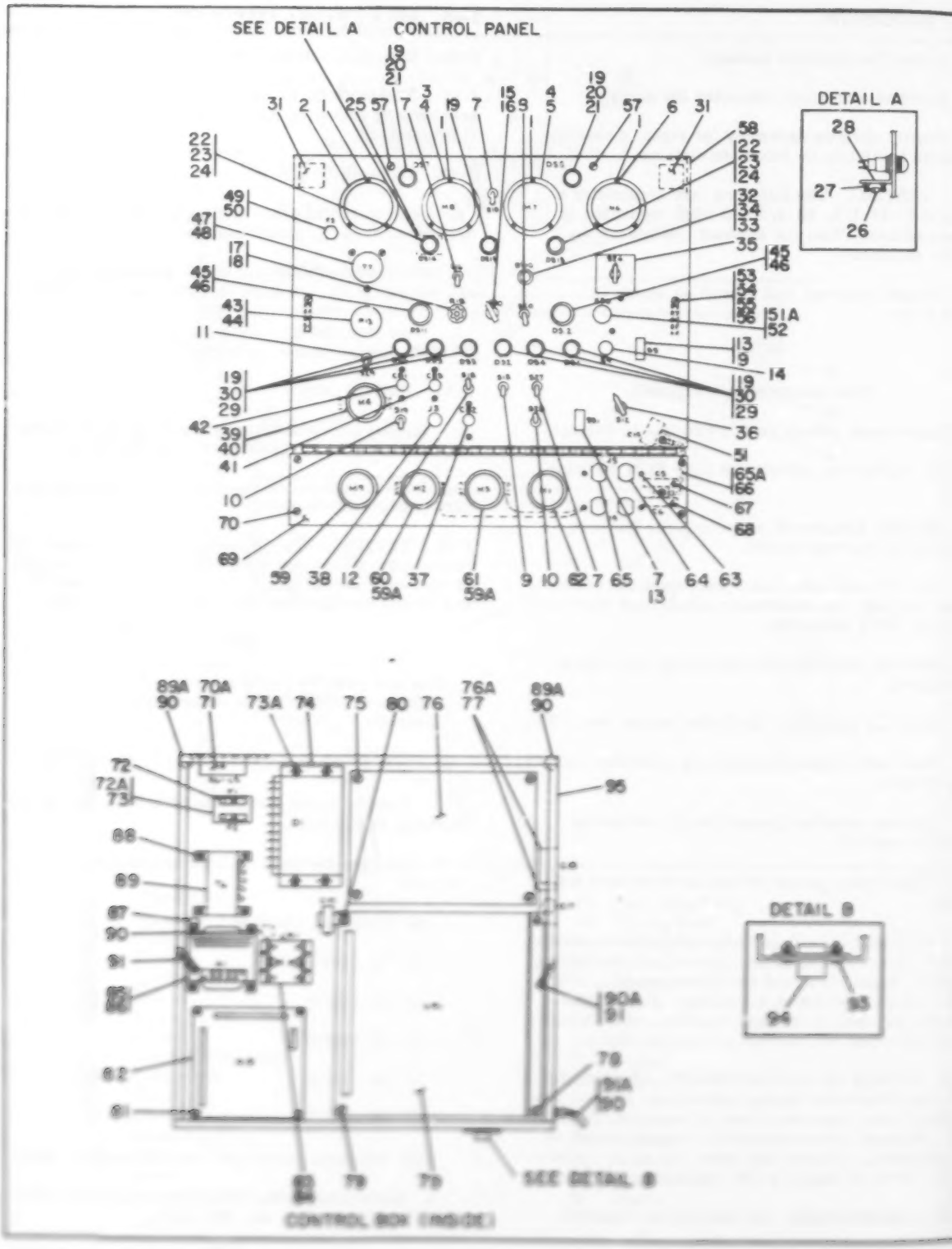
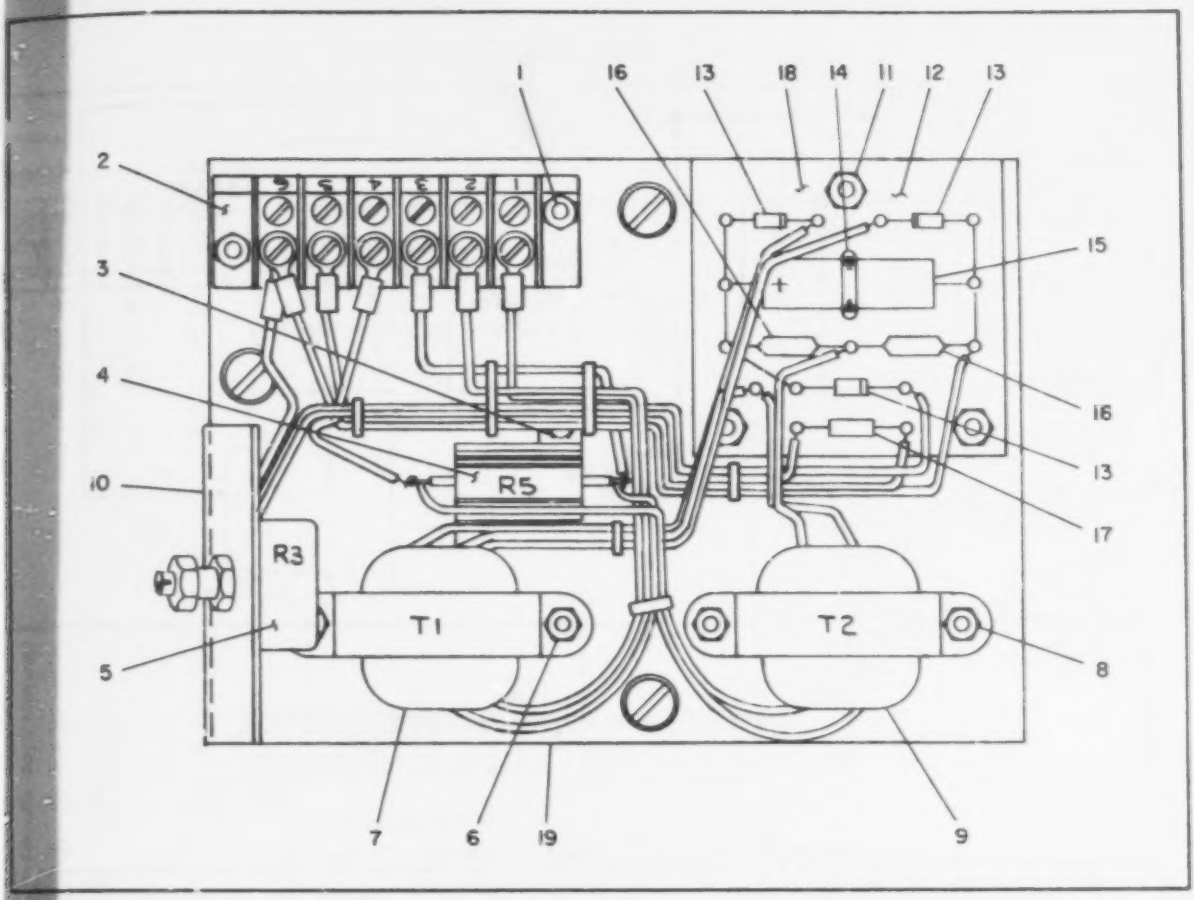

SEE DETAIL A
CONTROL PANEL
DETAIL A
DETAIL B
SEE DETAIL B
CONTROL BOX (INSIDE)

Legend to Figure 2-4

1. Screw, Lock Washer, Flat Washer, Nut
2. Wattmeter
3. Frequency Meter
4. Bezel
5. Ammeter AC
6. Voltmeter AC
7. Toggle Switch
8. Toggle Switch
9. Toggle Switch
10. Toggle Switch
11. Toggle Switch
12. Toggle Switch
13. Switch Guard
14. Push Switch
15. Rotary Switch Knob
16. Rotary Switch
17. Knob
18. Variable Resistor
19. Incandescent Lamp
20. Shield
21. Lampholder
22. Incandescent Lamp
23. Lens
24. Indicator Light
25. Zener Diode Assembly
26. Semiconductor Device Diode
27. Terminal
28. Bracket
29. Lens
30. Indicator Light
31. Rubber Bumper
32. Glow Lamp
33. Lens
34. Indicator Light
35. Rotary Switch
36. Rotary Switch
37. Circuit Breaker
38. Electrical Connector
39. Clamp
40. Battery Charging DC Ammeter
41. DC Circuit Breaker
42. Battery Charger Circuit Breaker
43. Knob
44. Voltage Adjustment Rheostat
45. Incandescent Lamp
46. Indicating Light
47. Variable Transformer
48. Knob
49. Fuse
50. Fuse Holder
51. Capacitor
51A. Screw, Flat Washer, Lock Washer, Nut
52. Relay
53. Machine Screw
54. Flat Washer
55. Lock Washer
56. Hex Plain Nut
57. Screw Assembly
58. Upper Control Panel
59. Water Temperature Meter Indicator
59A. Clamp
60. Oil Pressure Indicator
61. Fuel Quantity Indicator
62. Time Totalizing Meter
63. Screw, Lock Washer, Flat Washer, Nut
64. Electrical Receptacle Connector
65. Electrical Receptacle Connector
65A. Screw, Lock Washer, Nut
66. Ground Strap
67. Capacitor
68. Capacitor
69. Lower Control Panel
70. Screw, Flat Washer, Lock Washer
70A. Screw, Lock Washer, Spacer
71. Load Sharing Assembly
72. Fuse 15 Amp
72A. Screw
73. Fuse Block
73A. Screw, Lock Washer, Flat Washer
74. Thermal Watt Converter
75. Screw, Lock Washer, Flat Washer
76. Relay Panel Assembly
76A. Screw, Flat Washer, Lock Washer
77. Capacitor
78. Machine Screw
79. Voltage Regulator Assembly
80. Capacitor
81. Screw, Flat Washer, Lock Washer
82. Over and Under Voltage Monitor
83. Screw, Flat Washer, Lock Washer
84. Rectifier Assembly
85. Screw, Flat Washer, Lock Washer
86. Transformer Rectifier Assembly
87. Clamp
88. Screw, Lock Washer, Flat Washer
89. Battery Charger Transformer
89A. Screw, Nut
90. Rubber Bumper
90A. Screw, Flat Washer, Lock Washer, Tubing, Standoff
91. Chain
91A. Screw, Flat Washer, Lock Washer, Nut
92. Ground Strap
93. Screw, Lock Washer, Flat Washer, Nut
94. Harness Assembly
95. Control Box



1. Screw, nut
2. Terminal Board
3. Screw, lockwasher, nut
4. Fixed Resistor
5. Variable Resistor
6. Screw, nut
7. Potential Transformer
8. Screw, nut
9. Potential Transformer
10. Identification Plate
11. Screw, nut
12. Component Board Assembly
13. Diode Semiconductor Device
14. Electrical Retainer
15. Fixed Capacitor
16. Fixed Resistor
17. Fixed Resistor
18. Component Board
19. Chassis

Figure 2-5. Load Sharing Assembly

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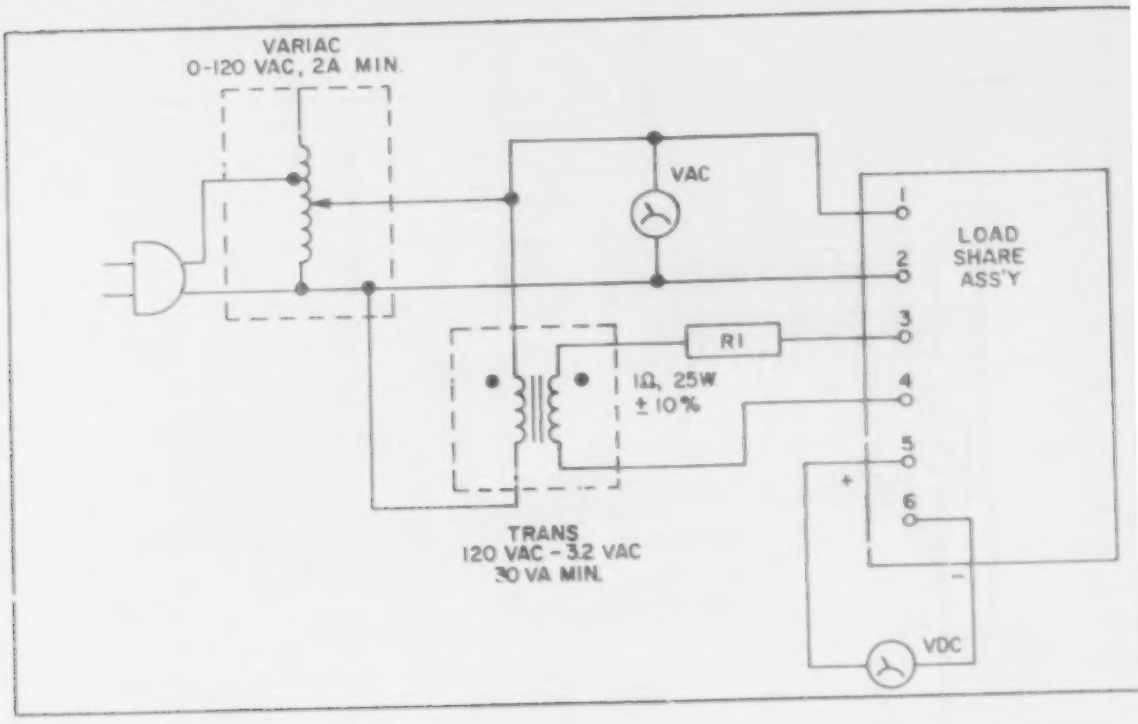


Figure 2-6. Load Sharing Test Circuit

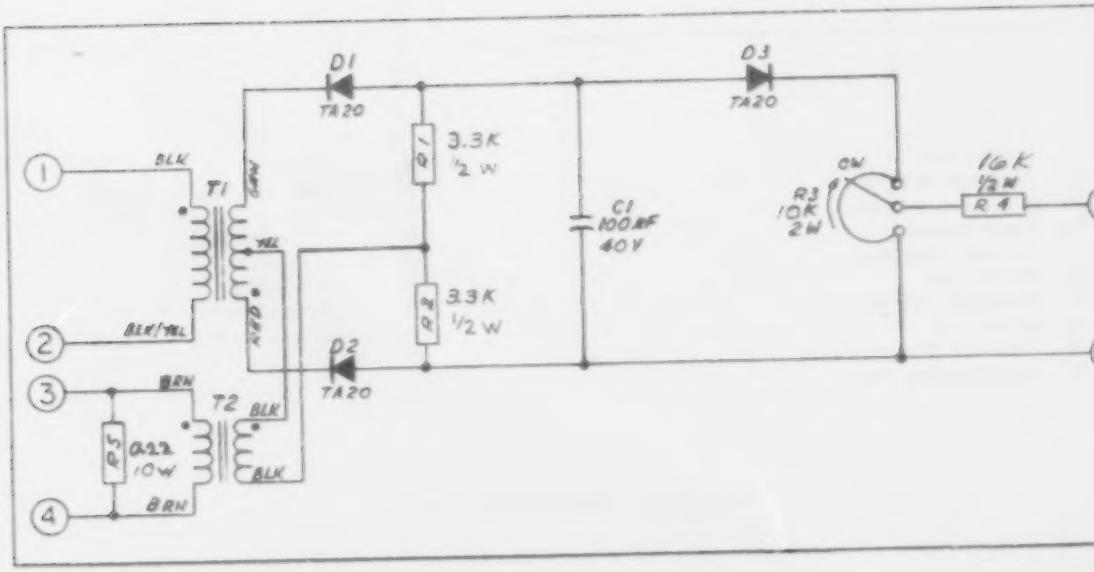


Figure 2-7. Load Sharing Schematic Diagram

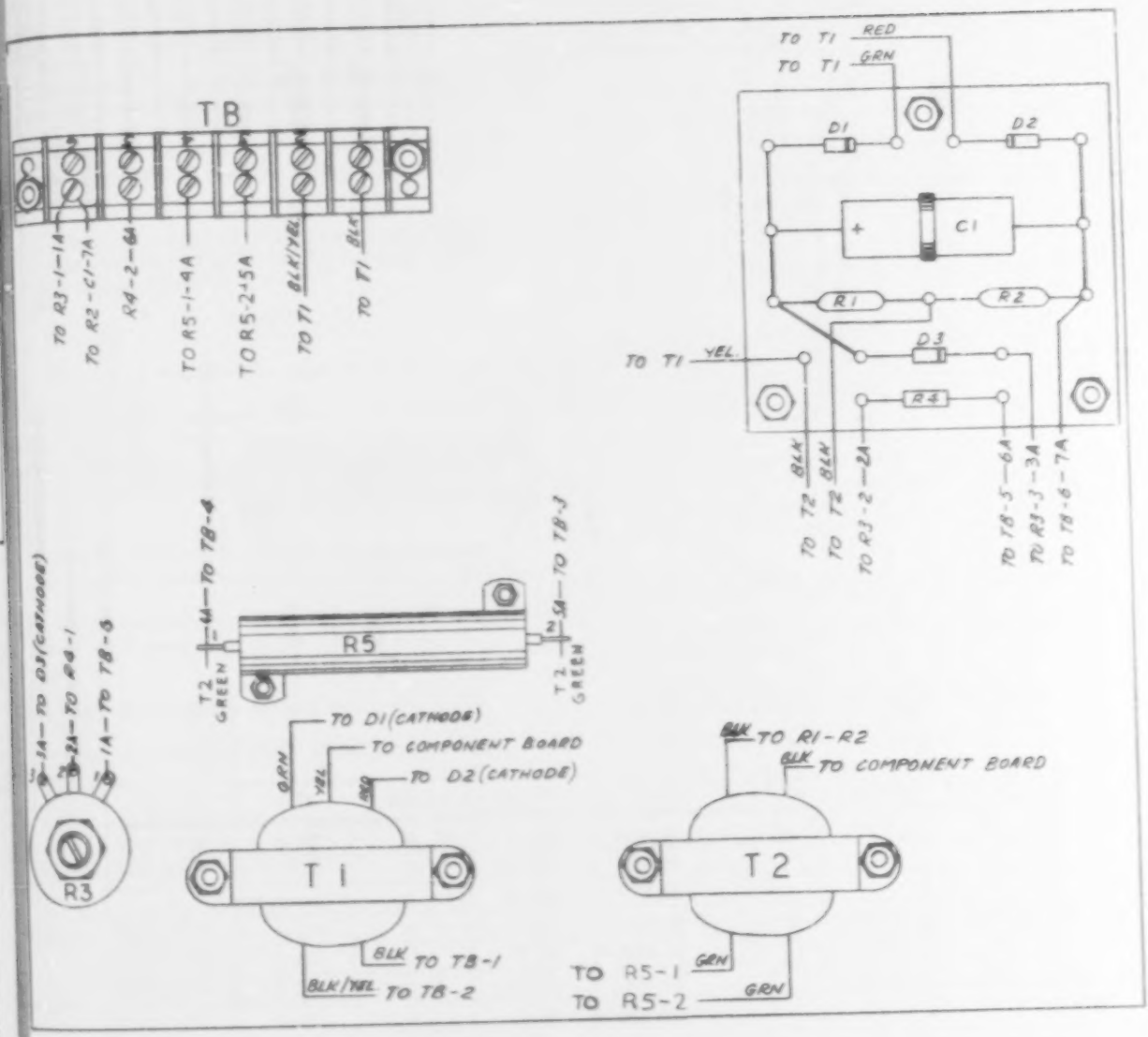
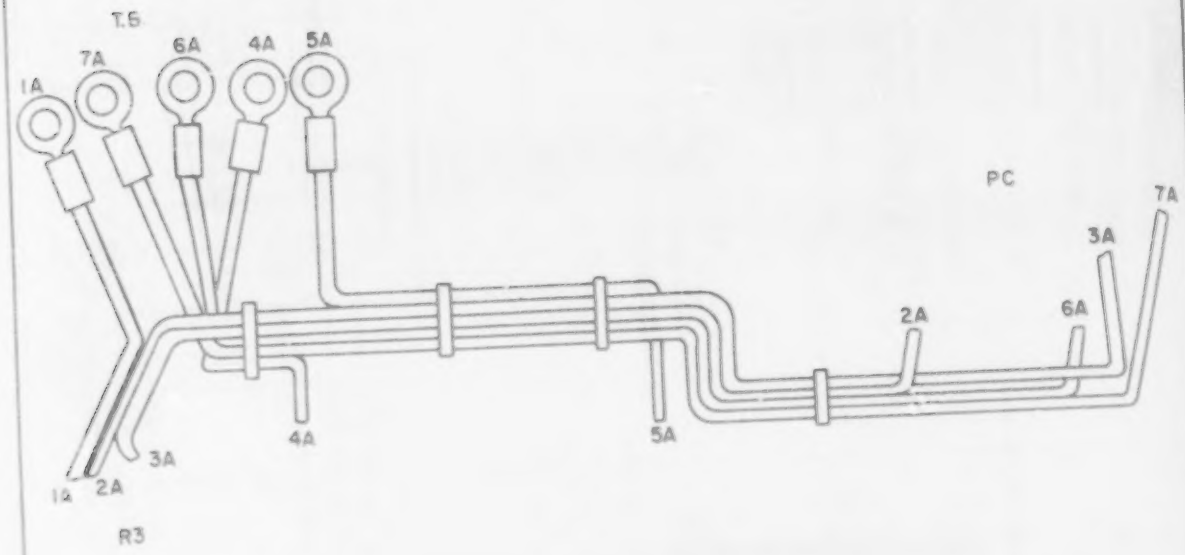


Figure 2-8. Load Sharing Wiring Diagram



WIRE NO	SIZE	LENGTH	COLOR	FROM	LUG	TO	LUG
1A	#20	3"	BLACK	R3-1	S	TB-6	S-979-0007
2A	#20	7"	BLACK	R3-2	S	R4-1	S
3A	#20	8"	BLACK	R3-3	S	D3 (cathode)	S
4A	#20	2 1/2"	BLACK	R5-1	S	TB-4	S-979-0007
5A	#20	3 1/2"	BLACK	R5-2	S	TB-3	S-979-0007
6A	#20	7"	BLACK	R4-2	S	TB-5	S-979-0007
7A	#20	8"	BLACK	R2-2	S	TB-6	S-979-0007
WIRE P/N 980-4048-0							

NOTES:
1. S IN LUG COLUMN DESIGNATES STRIPPED END WITHOUT LUG

Figure 2-8A. Load Sharing Wiring Harness and Cutting List

4. If above measured time is not within the imits of 9.5 ±0.1 seconds with an applied voltage f 28 Vdc adjust rheostat, R1 to achieve the proper ime.

NOTE

Clockwise rotation of rheostat R1 decreases and counterclockwise rotation increases time.

5. Specification tolerance of time given above is 10 seconds ±1 second over the voltage range of 18 to 30 Vdc.

6. Close switch S3 and count time from instant S3 is closed to instant DS1 and DS3 turn off. DS2 and DS4 should light.

NOTE

Use a stopwatch to register time.

7. If the above measured time is not within the limits of 1.0 ±1 second, adjust R17 to achieve the correct time.

NOTE

Clockwise rotation of rheostat decreases time and counterclockwise increases time.

8. Specification tolerance of time given above is second ±0.2 seconds over the voltage range 18 to 30 Vac.

9. End of time delay section setup.

b. CONTROL RELAY TEST PROCEDURE. (See figure 2-14).

1. Set switches S1, S2, and S3 off.

2. Set switch A to position No. 2.

3. Lamp DS4 should light. All other lamps should be off.

4. Depress test button PB2. Lamps DS1, DS2, and DS4 should light. Release test button PB2.

5. Depress test button PB1. Lamp DS1 should light and DS2, DS3, and DS4 should be off. Release test button PB1.

6. Set switch A to position No. 3 and switch S4 to ON.

7. Depress test button PB1. Lamps DS2, DS3, and DS4 should be off. Lamp DS1 should be on. Release test button PB1. Set switch S4 to OFF.

8. Set switch A to position No. 4. Lamps DS1, DS2, DS3, and DS4 should be OFF.

9. Depress test button PB1. Lamp DS4 should be off. Lamps DS1, DS2, and DS3 should be on. Release test button PB1.

10. Set switch A to position No. 5. Lamps DS1, DS2, and DS3 should be off and lamp DS4 should be on.

11. Depress test button PB1. Lamp DS1 should be on and lamps DS2, DS3, and DS4 should be off. Release test button PB1.

12. Set switch A to position No. 6 and set switch S5 to on. Lamps DS1, DS3, and DS4 should be off and lamp DS2 should be on.

13. Depress test button PB1. Lamps DS3 and DS4 should be off and DS1 and DS2 should be on. Release test button PB1.

14. Set switch A to position No. 7. All lamps should be off.

15. Depress test button PB1. Lamps DS2 and DS4 should be off. Lamps DS1 and DS3 should be on.

2-51. REPAIR OR REPLACEMENT. Refer to schematic, figure 2-15, and wiring diagrams, figures 2-16 and 2-16A and check individual components for proper values. Perform continuity test of all wiring. Replace components if defective. Repeat test after repair or replacement.

2-52. LUBRICATION. No lubrication required.

2-53. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-54. VOLTAGE REGULATOR ASSEMBLY.

2-55. SPECIAL TOOLS. No special tools required.

2-56. DISASSEMBLY. Disassemble the voltage regulator assembly by following the sequence of index numbers in figure 2-17.

2-57. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure, filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorethene N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered, low pressure, compressed air.

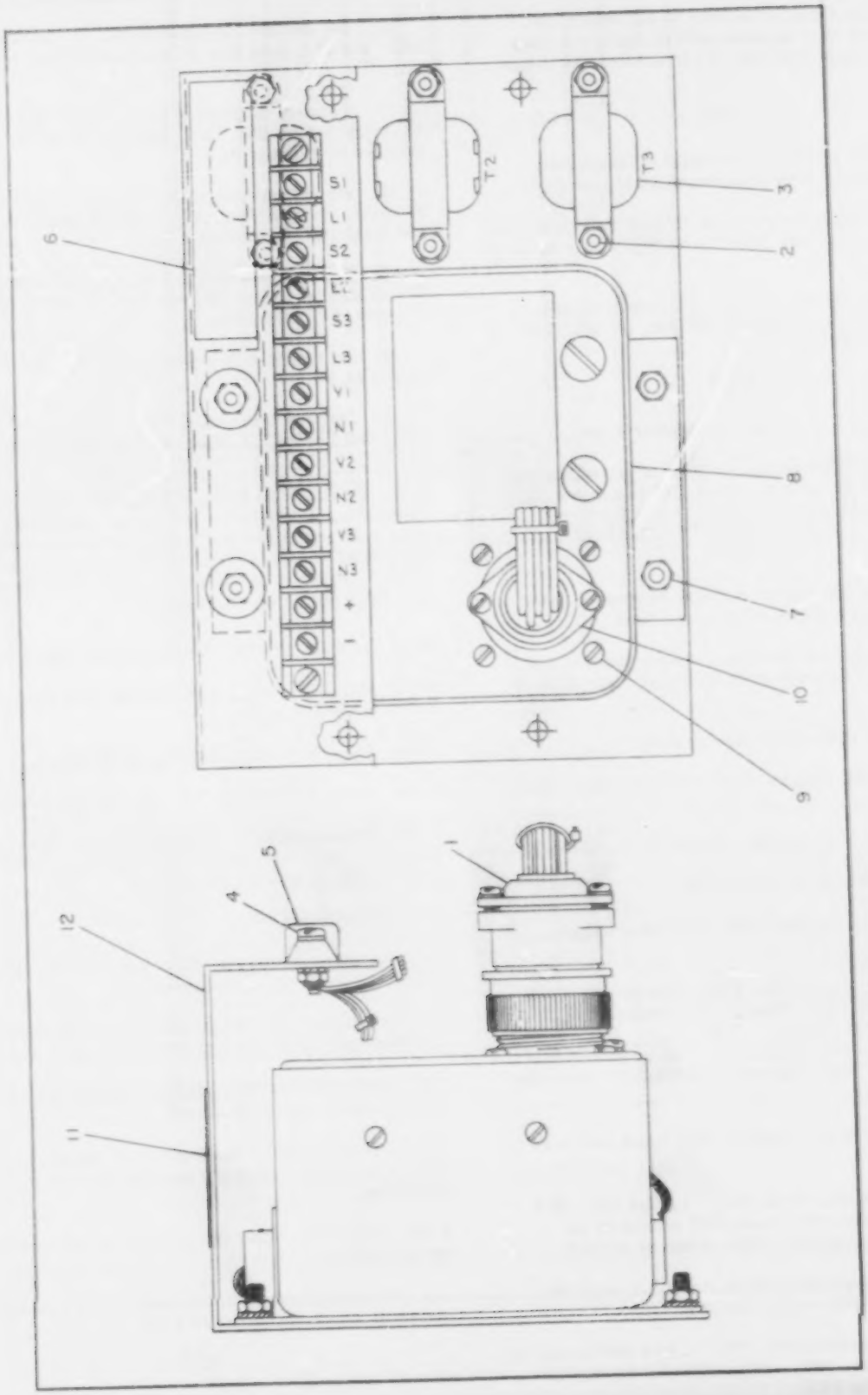
2-58. INSPECTION. Inspect all electrical parts and wiring for signs of overheating and charred or frayed insulation.

2-59. TESTING. Test the voltage regulator assembly as follows:

a. Connect external test circuit to voltage regulator assembly as shown in figure 2-18.

NOTE

Remove regulator cover before testing.


S1
L1
S2
E2
S3
L3
V1
N1
V2
N2
V3
N3
+
-
T2
T3
1
2
3
4
5
6
7
8
9
10
11
12

Legend To Figure 2-9

1. Harness Assembly
2. Nut, Lock Washer
3. Current Transformer
4. Screw, Nut
5. Terminal Board
6. Identification Plate
7. External Washer Nut
8. KW Meter Converter
9. Screw, Washer Nut
10. Electrical Receptacle Connector
11. Identification Plate
12. Mounting Plate

b. Set the voltage compensation pot to full CCW position.

c. Set stability control to full CW position.

d. Raise input voltage. The dc voltage should rise.

e. At 65 vac ±10%, relay K1 should pull in. Continue increasing the input voltage to 120 vac. At 120 vac it should be possible to control output voltage with the voltage adjust pot. With the output set to approximately 15 vdc, rotate the voltage compensation pot in a CW direction. The output should rise. Reset control to full CCW position.

f. With the input at 120 vac adjust the voltage across the 100 ohm load resistor for approximately 10 vdc output.

g. Open power circuit by opening switch S1.

h. Move jumper from point 13 to 24, to 13 to 28.

i. Close the power circuit by closing switch S1.

j. Reduce the ac input voltage until approximately 10 vdc is present across the 100 ohm load resistor. The voltage adjust pot should not be readjusted from setting used with 120 vac input. The input voltage should now be 110 vac to produce approximately 10 vdc across the load resistor.

k. Measure the dc voltage across capacitor C1 and noting whether the polarity of capacitor is correct. The voltage should be approximately 45 volts with 120 volts input and 50 volts output.

l. Measure the voltage across capacitor C2 and note whether polarity of capacitor is correct. The voltage should be approximately 50 vdc.

m. Measure the voltage across capacitor C3 and note whether polarity of capacitor is correct. The voltage should be approximately 140 vdc.

n. Turn off power and inspect wiring of L2, C2, R6 and terminals 7 and 8 of T1 to be correct with reference to schematic figure 2-19.

2-60. REPAIR OR REPLACEMENT. Refer to schematic, figure 2-19 and wiring diagram, figure 2-20, and check individual components for proper values. Perform continuity test of all wiring. Check transformer for open and shorted windings. Replace components if defective. Repeat test after repair or replacement. Refer to figure 2-20A for wiring harness and cutting list.

2-61. LUBRICATION. No lubrication required.

2-62. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-63. VOLTAGE AND FREQUENCY MONITOR ASSEMBLY.

2-64. SPECIAL TOOLS. No special tools required.

2-65. DISASSEMBLY. Disassemble the voltage and frequency monitor assembly by following the sequence of index numbers in figure 2-21. Refer to figure 2-21A for interconnect wiring.

2-66. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure, filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorethene N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered, low pressure, compressed air.

2-67. INSPECTION.

a. Inspect all electrical parts and wiring for signs of overheating and charred or frayed insulation.

b. Check that all three cards are firmly plugged into the chassis assembly.

2-68. TESTING.

a. PREPARATION FOR CALIBRATION AND TEST.

1. On voltage sensing card, turn undervoltage adjusting controls R17, R19, R21 fully counterclockwise and overvoltage adjusting controls R18, R20, and R22 fully clockwise.

2. On frequency sensing card, turn underfrequency adjusting screw fully clockwise.

3. On switching card, turn overvoltage time delay adjusting control R42 fully counterclockwise.

4. Turn undervoltage time delay adjusting control R41 fully clockwise.

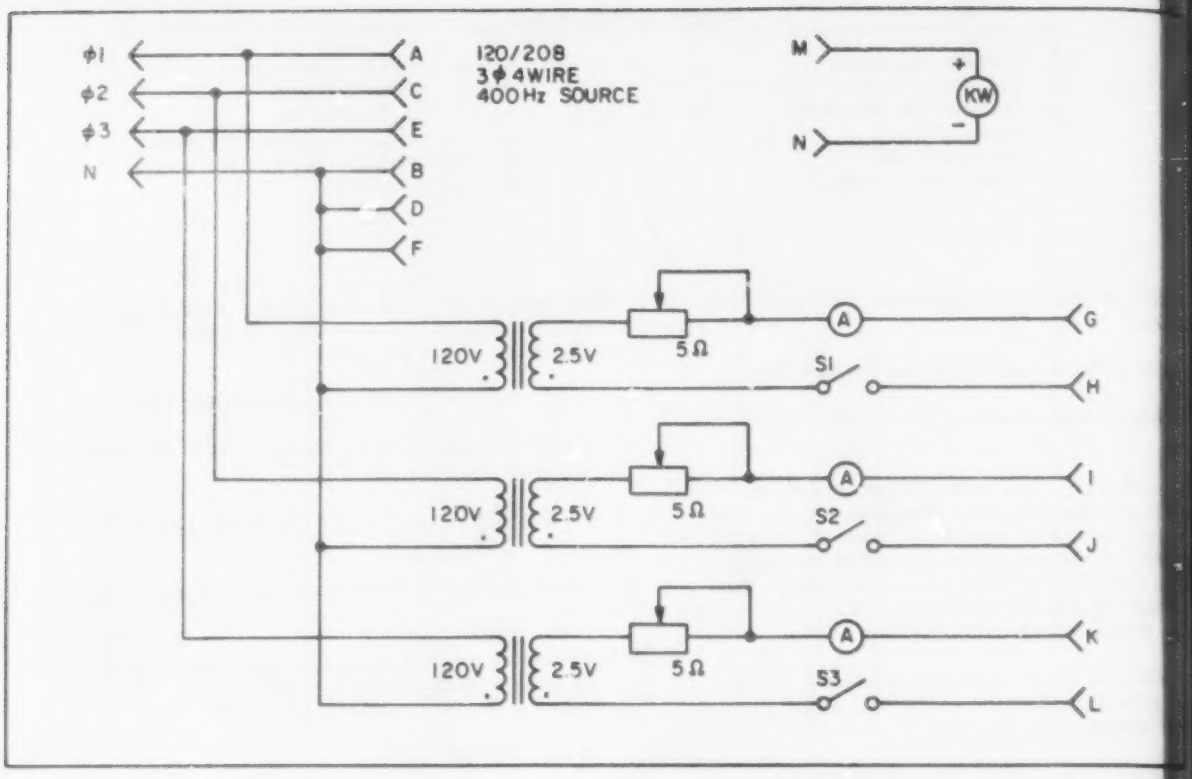


Figure 2-10. Kilowatt Transducer Assembly Test Circuit

5. Connect monitor assembly to test equipment as shown in figure 2-22.

6. Place Var/Fixed Frequency Selector Switch S504 in the 3 phase supply position (pos. 2). Place Transformer Phase Selector Switches S501, S502, and S503 in the Fixed position (pos. 1). All indicator lamps should be unlighted.

7. On voltage sensing card, adjust R5, R4, and R3 to center of range.

b. OVERVOLTAGE/UNDERVOLTAGE CALIBRATION AND TEST.

NOTE

Tests to be performed for 50 HZ first.

1. Undervoltage 50 HZ setting (calibrate to trip between 94.5 and 99 vac).

(a) Place 50/60 HZ voltage selector switch (S506) in the 50 HZ position (closed).

(b) Place one of the transformer phase selector switches, S501, S502, or S503 in the variable position (pos. 2) and the voltmeter phase selector switch (S505) in the respective phase position.

(c) Adjust the transformer output voltage of t same phase until voltmeter (V501) indicates 95 vol

(d) On the voltage sensing card, turn the und voltage adjusting screw of the corresponding phas (R21 for phase 1, etc) clockwise slowly to the poin at which the undervoltage lamp lights.

NOTE

Fault indicator lamp R. P. will light when any fault condition exists, and indicates that relay K501 is energized.

(e) Readjust transformer voltage output of ph just tested until voltmeter again indicates nominal (120) voltage, then press reset switch (S508). Fa lamps will go out.

NOTE

Always readjust transformer voltage output to nominal voltage before pressing reset switch, to assure proper settings.

(f) To test for proper setting, slowly lower t transformer voltage output of the same phase. Un voltage lamp will light when voltage drops to betw 94.5 and 99 vac. Adjust voltage and press reset switch as above.

WIRE NO. (WIRE LOCATION)	SIZE (AWG)	LENGHT (IN.)	COLOR	FROM	LUG	TO	LUG
1A	#20	14	BLACK	T1 - 3	S	PIN G	S
2A		13-3/4		T1 - 4		" H	
3A		12-1/2		T2 - 3		" I	
4A		12		T2 - 4		" J	
5A		13-1/8		T3 - 3		" K	
6A		12-1/2		T3 - 4		" L	
7A		8-3/4		TB-V_1		" A	
8A		9-1/4		TB-N_1		" B	
9A		9-1/2		TB-V_2		" C	
10A		9-3/4		TB-N_2		" D	
11A		10-1/2		TB-V_3		" E	
12A		11		TB-N_3		" F	
13A		11-1/2		TB - +		" M	
14A		11-1/4		TB - —		" N	
15A		7-1/2		T1 - 1		TB - S_1	
16A		7-1/4		T1 - 2		TB - L_1	
17A		7-1/4		T2 - 1		TB - S_2	
18A		7-1/4		T2 - 2		TB - L_2	
19A		9-1/2		T3 - 1		TB - S_3	
20A	#20	9-1/2	BLACK	T3 - 2	S	TB - L_3	S

NOTES:

1. PINS ARE ON MS CONNECTOR (MS-3106R-20-27S)
2. ALL LEADS STRIPPED 1/2" & TINNED BEFORE ASSEMBLY.
3. S IN LUG COLUMN DESIGNTES STRIPPED END WITHOUT LUG.

Figure 2-12A. Kilowatt Transducer Wire Cutting List

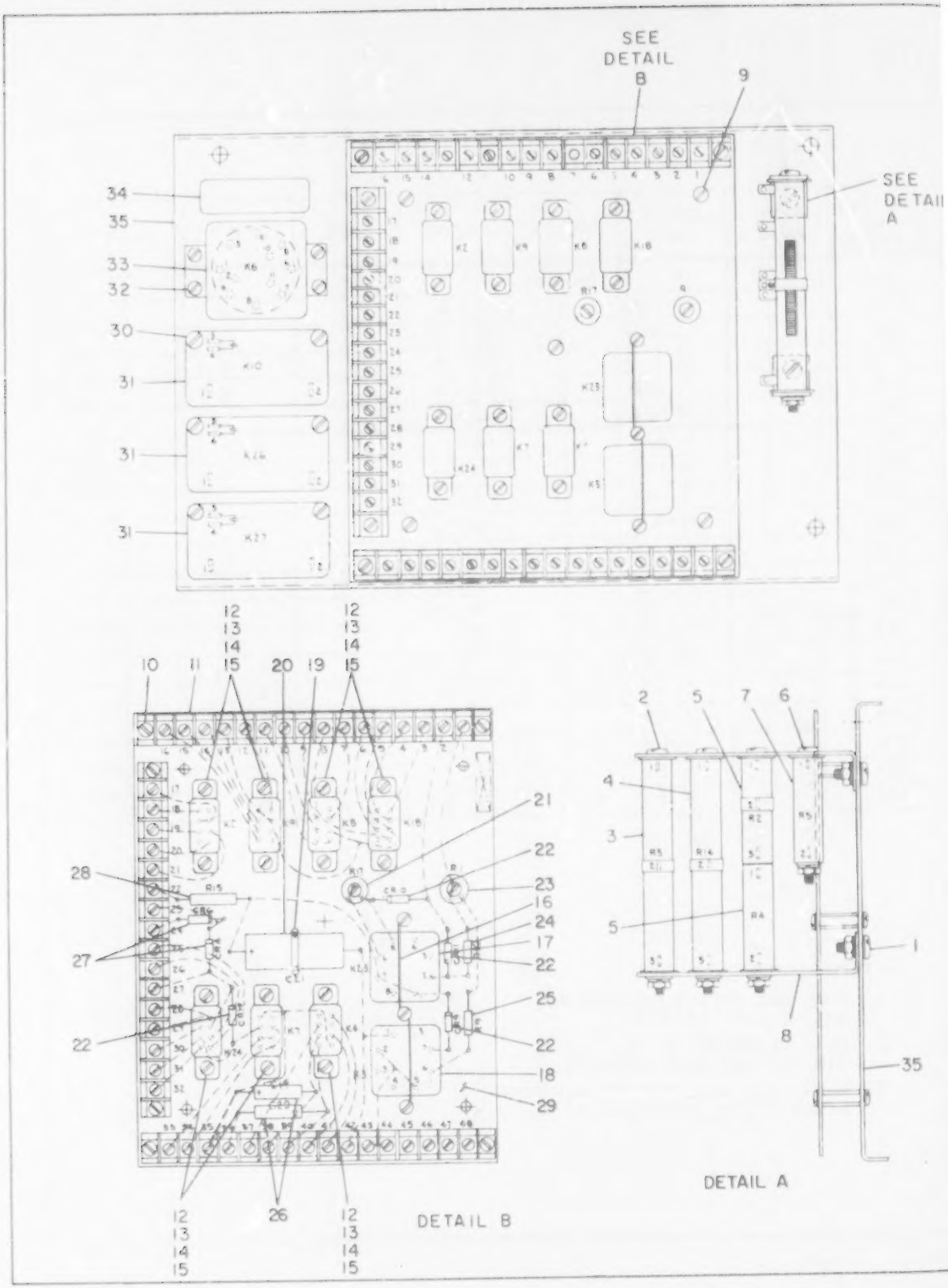


Figure 2-13. Relay Panel Assembly

Legend To Figure 2-13

1. Assembled Washer Screw, Nut
2. Screw, Lock Washer, Flat Washer
3. Adjustable Resistor
4. Adjustable Resistor
5. Adjustable Resistor
6. Machine Screw
7. Adjustable Resistor
8. Bracket
9. Assembled Washer Screw
10. Screw, Nut
11. Terminal Board
12. Screw
13. Relay
14. Nut
15. Relay Socket
16. Retaining Spring, Screw, Flat Washer, Standoff
17. Time Delay Relay
18. Relay Socket
19. Electrical Retainer
20. Fixed Capacitor
21. Variable Resistor
22. Diode Semiconductor Device
23. Variable Resistor
24. Fixed Resistor
25. Fixed Resistor
26. Capacitor
27. Semiconductor Device Diode
28. Fixed Resistor
29. PC Board
30. Machine Screw
31. Thermal Relay
32. Assembled Washer Screw
33. Engine Run Relay
34. Identification Plate
35. Mounting Plate

(g) Follow steps (b) through (f) above for the remaining two phases. (Adjust R19 for phase 2 and R17 for phase 3).

2. Overvoltage, 50 HZ setting (calibrate to trip between 130 and 135 vac).

(a) Be sure 50/60 HZ voltage selector switch (S506) is in the 50 HZ (closed) position.

(b) Place one of the transformer phase selector switches S501, S502, or S503 in the variable position, (pos. 2) and the voltmeter phase selector switch (S505) in the respective phase position.

(c) Adjust the transformer output voltage of the same phase until voltmeter (V501) indicates 130 volts.

(d) On the voltage sensing card, turn the overvoltage adjusting screw of the corresponding phase (R22 for phase 1, etc.) counterclockwise slowly, until the overvoltage lamp just lights.

(e) Readjust transformer voltage output of phase just tested until voltmeter again indicates nominal (120) voltage, then press reset switch (S508). Fault lamps will go off.

(f) To test for proper setting, slowly raise the transformer voltage output of the same phase. Overvoltage lamp will light when voltage reaches 130 - 135 volts ac. Adjust voltage and press reset switch as above.

(g) Follow Steps (b) through (f) above for remaining two phases. (Adjust R20 for phase 2 and R18 for phase 3).

3. Undervoltage, 60 Hz setting (trip range between 105 - 110 vac).

(a) Place 50/60 Hz voltage selector switch (S506) in the 60 Hz (open) position.

(b) Proceed as in paragraph 1(b).

(c) Lower transformer voltage output slowly. Undervoltage lamp should light when indicated voltage is between 105 and 110 volts ac. Raise output voltage to nominal (120) voltage, and press reset switch. Test the remaining two phases the same way.

(d) If undervoltage trip point for any phase does not fall within the above indicated limits, rheostat R5, R4, and R3 (controlling phase 1, 2, and 3 respectively, and located on sensing card) must be trimmed as follows:

(1) While lowering the transformer output voltage, if the undervoltage lamp lights before the voltage reaches 110 volts or below, adjust the respective rheostat clockwise.

(2) If the undervoltage lamp lights after the voltage has been lowered below 105 volts, adjust the respective rheostat counterclockwise.

(3) As a precaution, recheck undervoltage and overvoltage trip points for 50 and 60 Hz.

4. Overvoltage, 60 Hz setting (trip range between 145 - 150 vac).

(a) Be sure 50/60 Hz voltage selector switch is in the 60 Hz (open) position.

(b) Proceed as in paragraph 2(b).

(c) Raise transformer voltage slowly. Overvoltage lamp should light when indicated voltage is between 145 and 150 vac. Lower output voltage to nominal (120) voltage and press reset switch. Test the remaining two phases the same way.

c. UNDERFREQUENCY CHECK (Calibrate to trip between 44 and 46 Hz).

1. Place the var/fixed frequency selector switch (S504) in the variable position (pos. 1). The 50/60 Hz voltage selector switch may be placed in either position (open or closed).

2. Place transformer phase selector switch S501 in the variable position (pos. 2), and switches S502 and S503 in the fixed position (pos. 1). Adjust phase 1 voltage to 120 volts.

3. Adjust the variable frequency supply until the frequency meter (F501) indicates 45 Hz.

4. On frequency sensing card, turn the underfrequency adjusting screw counterclockwise slowly, until the underfrequency lamp just lights. Then readjust the variable frequency supply back to approx. 50 Hz and press reset switch (S508).

5. To check trip point, slowly lower frequency. Underfrequency lamp should light between 44 and 46 Hz. Raise frequency to approx. 50 Hz and press reset switch.

d. OVERCURRENT TEST.

1. All 3 phases of the transformer output must be set at 120 vac. The 50/60 Hz voltage selector switch may be placed in either position (open or closed).

2. Press overcurrent test switch (S506). Overcurrent lamp should light.

e. UNDERVOLTAGE TIME DELAY (Set for 8 seconds +1 -0).

1. 50/60 Hz voltage selector switch may be placed in either position (open or closed).

2. Place all the transformer phase selector switches in the variable position (pos. 2).

3. On switching card, turn undervoltage time delay adjusting counterclockwise 1/2 turn.

4. Lower transformer output voltage (all three phases) to trip point. Use stopwatch or other suitable timer to check time lapse between time trip point is reached and undervoltage lamp lights. Raise voltage to nominal (120) and press reset switch. Repeat above steps adjusting undervoltage time delay screw until time lapse between trip point is reached and undervoltage lamp lights in 8 seconds, plus 1 second, minus 0 seconds.

f. OVERVOLTAGE TIME DELAY (Set for 1.5 seconds +5 -0).

1. Same as for undervoltage time delay steps (1) and (2).

2. On switching card, turn overvoltage time delay adjusting screw clockwise 1/4 turn.

3. Raise transformer output voltage (all three phases) to trip point. Use stopwatch or other suitable timer to check time lapse between time trip point is reached and overvoltage lamp lights. Lower voltage to nominal (120) and press reset switch. Repeat above steps, adjusting overvoltage time delay screw until lapse between time trip point is reached and overvoltage lamp lights is 1.5 seconds, plus 0.5 second, minus 0 seconds.

g. INDIVIDUAL CARD TESTING. The individual cards (voltage sensing unit, switching unit and frequency sensing unit) may be pretested for proper operation using the same equipment described here with the following restrictions:

1. Use a monitor assembly that has been completely tested and found acceptable.

2. Follow procedures (4) and (5) in paragraph

3. If individual voltage sensing cards are to be pretested, remove existing voltage sensing card and replace with one to be tested. If frequency sensing card is to be pretested, remove existing frequency card, etc. Pretest only one "untested" card at a time.

4. The 50/60 Hz voltage selector switch (S506) should be placed in 50 Hz position (closed).

5. Depending on which module is to be pretested, follow undervoltage, overvoltage (50 Hz setting), underfrequency and overcurrent test procedures, as applicable.

2-69. REPAIR OR REPLACEMENT. Refer to schematic, figure 2-23 and wiring diagram, figure 2-24 and check individual components for proper values. Perform continuity test of all wiring. Check transformers for open and shorted windings. Replace components if defective. Repeat test and calibration after repair or replacement.

2-70. LUBRICATION. No lubrication required.

2-71. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-72. RECTIFIER ASSEMBLY.

2-73. SPECIAL TOOLS. No special tools required.

2-74. DISASSEMBLY. Disassemble the rectifier assembly by following the sequence of index numbers in figure 2-25.

2-75. CLEANING.

a. Remove surface dirt or dust by blowing with pressure, filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorethene N. U., Federal Specification O-T-62

c. Wipe with lint free cloth and air dry with filtered, low pressure compressed air.

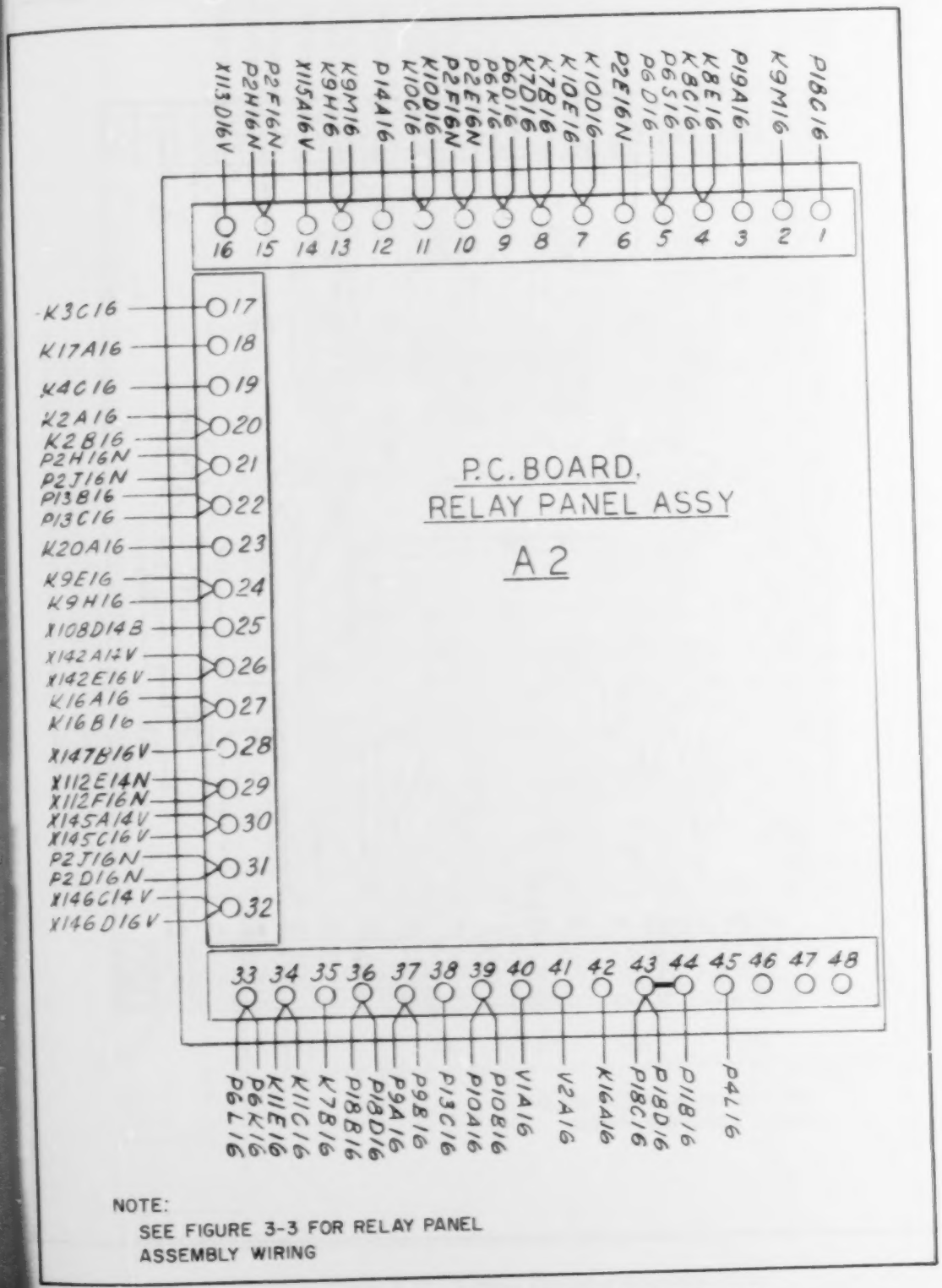
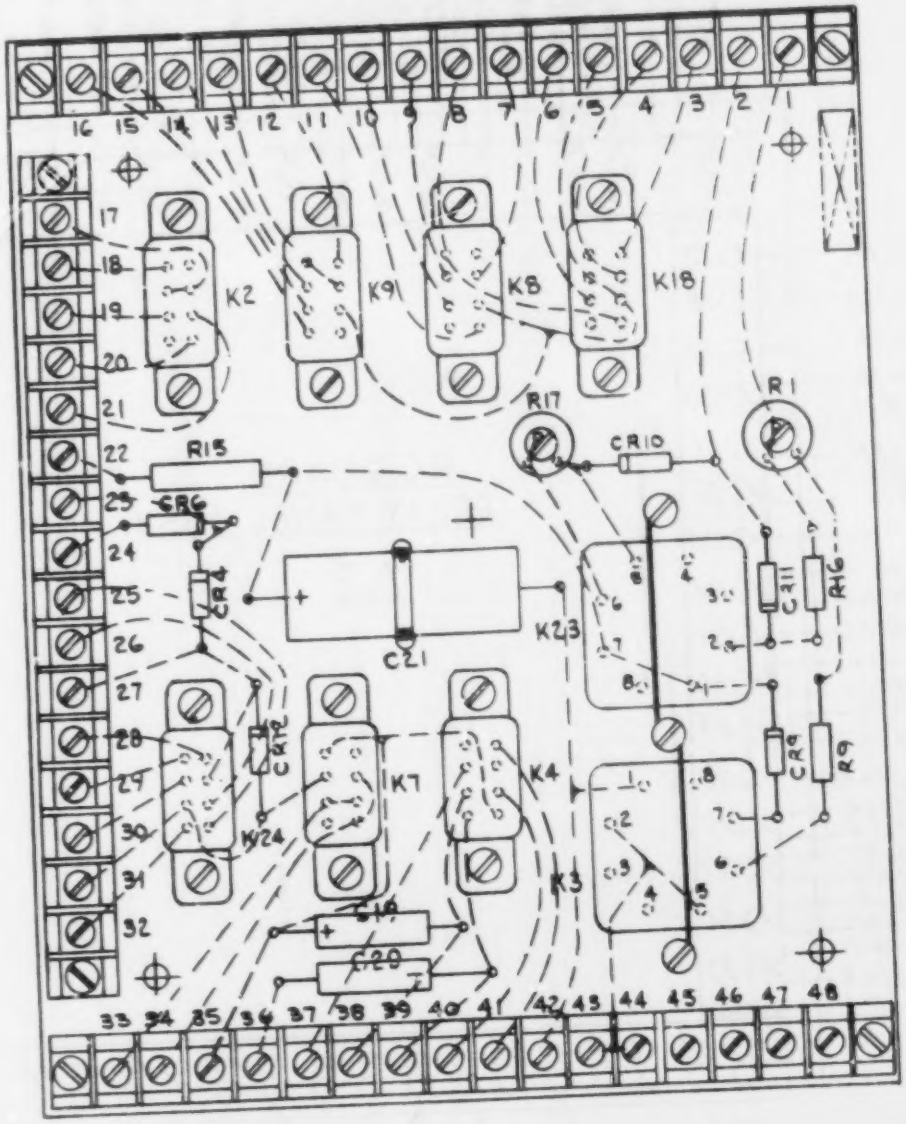


Figure 2-16. Relay Panel Wiring Diagram (to P.C. Board)



NOTE:
SEE FIGURE 3-3 FOR RELAY PANEL ASSEMBLY WIRING.

Figure 2-16A. Relay Panel Wiring Diagram

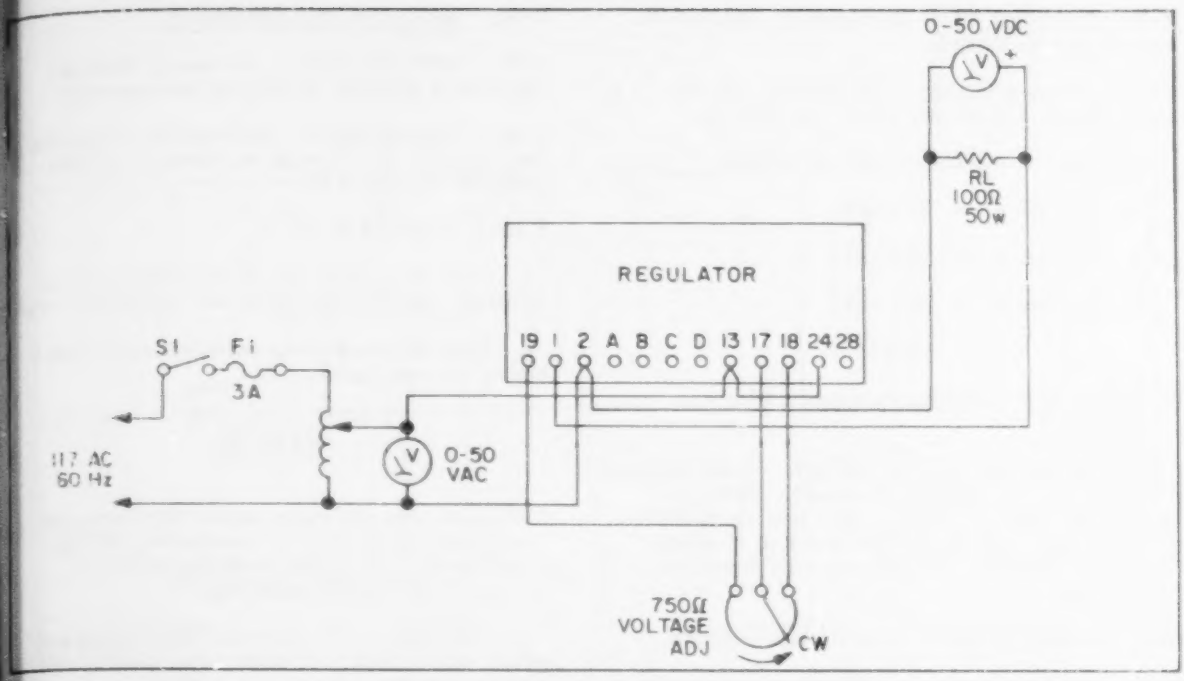


Figure 2-18. Voltage Regulator Test Circuit

2-76. INSPECTION.

a. Inspect all parts for visible damage.

b. Inspect wiring and attaching hardware.

2-77. TESTING.

a. Refer to figure 2-26. Label and remove all wiring to rectifier assembly.

b. Apply a known input to points labeled AC of 40 volts ac rms, 7.75 amp.

c. Check output with dc voltmeter attached to + and - points labeled on rectifier assembly. Output should be 28 volts dc, 7 amp.

d. If this reading is not obtained, check volts dc on individual diodes and replace as necessary.

e. Reconnect external wiring in accordance with interconnecting wiring diagram as shown in figure 2-26.

2-78. REPAIR OR REPLACEMENT. Refer to figure 2-26 and test each diode. Be sure to observe current direction. An oscilloscope will display a straight line trace for an open diode. A shorted diode will cause the oscilloscope to trace full cycles of supply power. A properly functioning diode will result in a half-wave rectified display.

2-79. LUBRICATION. No lubrication required.

2-80. REASSEMBLY. Reassemble in the reverse order of disassembly. Refer to figure 2-26 for wiring diagram.

2-81. TRANSFORMER RECTIFIER ASSEMBLY.

2-82. SPECIAL TOOLS. No special tools required.

2-83. DISASSEMBLY. Disassemble the transformer rectifier by following the sequence of index numbers in figure 2-27.

2-84. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure, filtered, compressed air.

b. Clean with soft bristle brush moistened with chlorethene N.U., Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered, low pressure, compressed air.

2-85. INSPECTION.

a. Inspect all electrical parts and wiring for signs of overheating and frayed insulation.

b. Inspect transformer for signs of insulation breakdown, physical damage and loose terminals.

2-86. TESTING. Refer to schematic, figure 2-28, and proceed as follows:

a. Apply input voltage of 120 volts ac, 60 Hz, single phase to terminals 1 and 5 of rectifier.

b. Output voltage should read as follows:

1. Terminals 1-2: 60V ±4%
2. Terminals 1-3: 70V ±4%
3. Terminals 1-4: 80V ±4%

NOTE

Taps to be tested individually with 4 ampere load.

2-87. REPAIR OR REPLACEMENT. Check diodes for damage and replace as necessary. Refer to schematic, figure 2-28 for proper polarity of diodes. Check transformer for shorted and open windings. Replace if damaged. Repeat test after repair or replacement.

2-88. LUBRICATION. No lubrication required.

2-89. REASSEMBLY. Reassemble in the reverse order of disassembly. Refer to figure 2-28 for wiring information.

2-90. FUEL LEVEL CONTROL.

2-91. SPECIAL TOOLS. No special tools required.

2-92. DISASSEMBLY. No disassembly required. Sealed component.

2-93. CLEANING. Clean external portion of the fuel level control with a lint free cloth moistened in Chlorothene N.U., Federal Specification O-T-620C.

2-94. INSPECTION.

a. Examine terminal board for broken barrier strips and missing hardware.

b. Check fuse holder for damage.

c. Check fuse. Correct amperage rating is 2 amperes.

d. Shake assembly and check for loose components within container.

2-95. TESTING. Test fuel level control in accordance with instructions in figure 2-29.

2-96. REPAIR OR REPLACEMENT. Replace fuel level control if it fails to pass the test as required.

2-96A. LUBRICATION. No lubrication required.

2-96B. REASSEMBLY. No reassembly required.

2-97. BATTERY BOX ASSEMBLY.

2-98. SPECIAL TOOLS. No special tools are required to overhaul the battery box assembly.

2-99. DISASSEMBLY. Disassemble the battery box assembly by following the sequence of index numbers in figure 2-30.

2-100. CLEANING.

a. Clean corrosion from battery box, cable assemblies, and adjacent parts with a stiff wire br

b. Wash corroded metal parts with a solution o baking soda and water.

WARNING

Battery acid will cause severe skin burns and eye damage on contact. Protective clothing and some form of eye protection should be worn when handling batteries.

c. Clean battery compartment drain tubes wit soapy water, flush with clean water, and dry wit compressed air.

2-101. INSPECTION. Inspect battery cable ass blies for wear. Check level and specific gravity battery fluid. Inspect hose and hose fittings for rosion. Check battery box for corrosion.

2-102. TESTING.

2-103. GENERAL.

a. Refill batteries to proper level and check specific gravity with hydrometer.

b. Test batteries for proper 12 volts output.

c. Test battery cables for continuity.

2-104. HEATING ELEMENT AND THERMOST SWITCH. The battery box heating element and thermostatic switch are designed to maintain ba box temperature between 40°F and 110°F. Test follows:

a. Connect the heating element to the thermo switch.

b. Connect the switch to a 24 volts dc source power. Turn power on.

c. Provide a means for cooling the element check to see that switch cuts element in a 40°F

d. Provide a means for heating the element check to see that switch cuts element out at 11

e. If circuit fails to respond, test element a switch separately.

2-105. REPAIR OR REPLACEMENT. Replace defective and badly corroded parts. Use standard battery charging procedures to recharge rundown batteries. Repaint box surfaces as required. Replace defective cables. Replace thermostatic switch and heating element as necessary.

2-106. LUBRICATION. No lubrication is required.

2-107. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-108. CONTACTOR INSTALLATION.

2-109. SPECIAL TOOLS. No special tools are required to overhaul the contactor assembly.

2-110. DISASSEMBLY. Disassemble the contactor assembly by following the sequence of index numbers in figures 2-31 and 2-32.

2-111. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

2-212. INSPECTION. Visually inspect all parts for wear, pitting, corrosion, and other signs of deterioration and damage. Inspect insulation.

2-113. TESTING. Test coils of contactor (S4) with a 12 volts dc source of power. The dc supply should be capable of supplying 10 amperes.

2-114. REPAIR OR REPLACEMENT. Replace defective parts. Burnish all contacts that are pitted.

2-115. LUBRICATION. No lubrication is required.

2-116. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-117. AIR CLEANER INSTALLATION.

2-118. SPECIAL TOOLS. No special tools are required to overhaul the air cleaner installation.

2-119. DISASSEMBLY. Disassemble the air cleaner installation by following the sequence of index numbers in figure 2-33.

2-120. CLEANING.

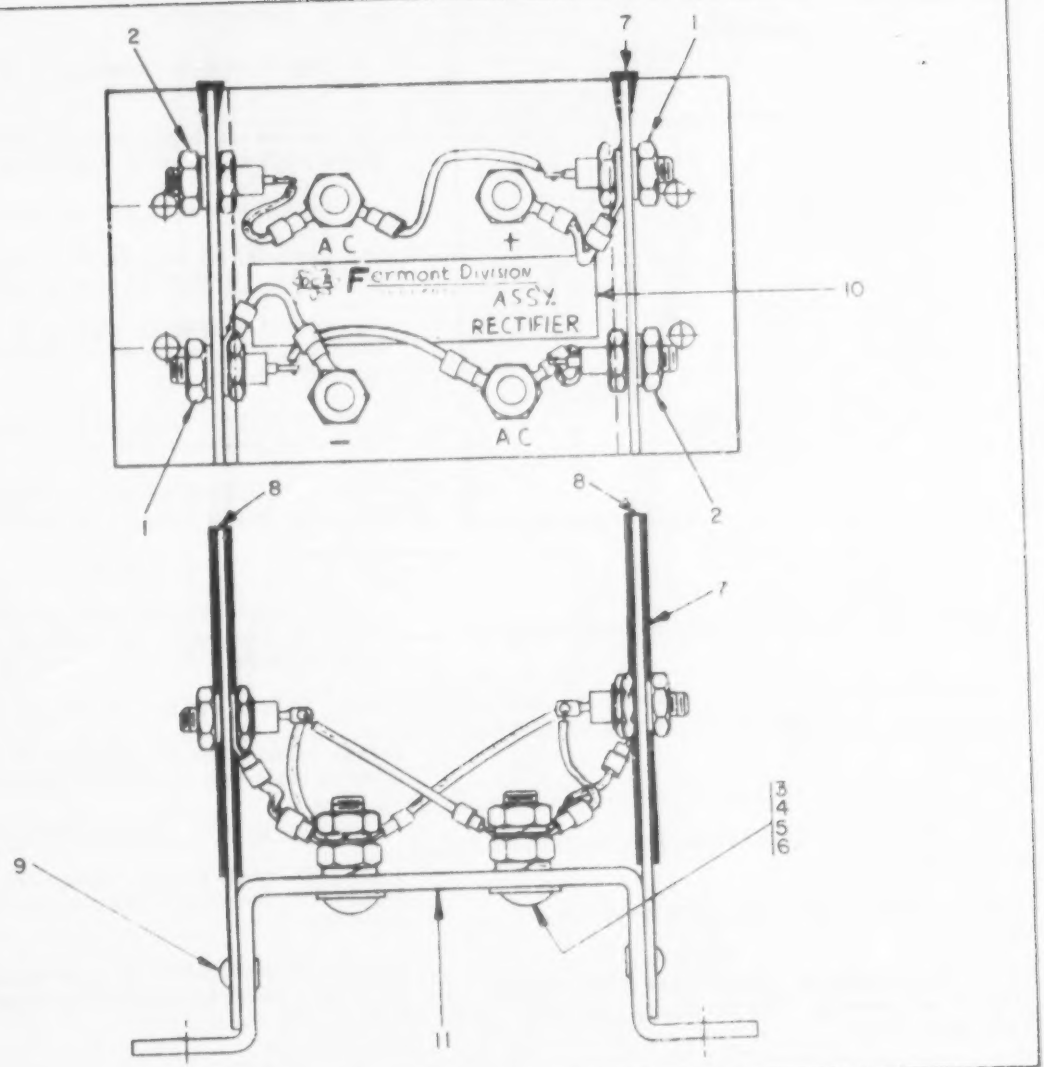
a. Clean sludge from cup (13).

b. Immerse air cleaner parts in cleaning solvent, Federal Specification P-S-661.

c. Use a vigorous swishing action to circulate solvent throughout the immersed air cleaner parts.

d. Rinse the air cleaner parts in clean solvent and dry with compressed air.

e. Clean dirt and sludge from prefilter (9). with compressed air.



1. Diode Semiconductor Device
2. Diode Semiconductor Device
3. Carriage Bolt
4. Lock Washer
5. Plain Hex Nut
6. Flat Washer
7. Rubber Extrusion
8. Heat Sink
9. Rivet
10. Identification Plate
11. Chassis

Figure 2-25. Rectifier Assembly

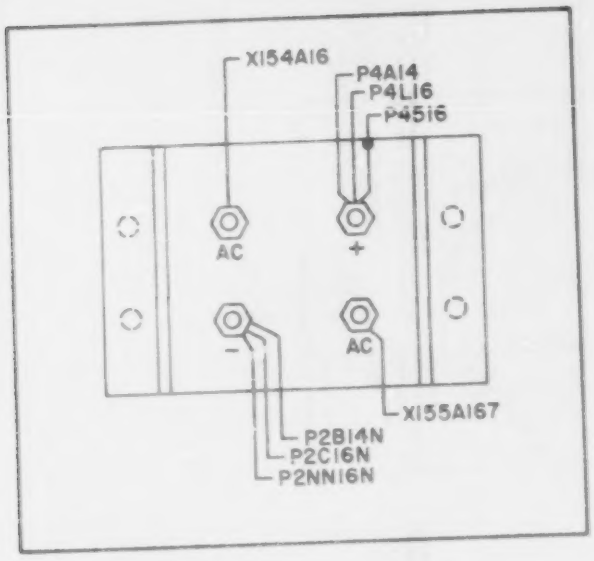


Figure 2-26. Rectifier Interconnecting Wiring

2-121. INSPECTION. Inspect flexible hose, prefilter, gasket, disk, and cup for signs of corrosion and general deterioration.

2-122. TESTING. No testing is required.

2-123. REPAIR OR REPLACEMENT. Replace all defective parts.

2-124. LUBRICATION. Dip prefilter in clean engine oil.

2-125. REASSEMBLY. Reassemble in the reverse order of disassembly. Fill air cleaner cup with 5-1/2 quarts of oil.

2-126. ELECTRIC GOVERNOR CONTROL ASSEMBLY.

2-127. SPECIAL TOOLS. No special tools required.

2-128. DISASSEMBLY. Remove four screws (3) and disassemble the computer electric governor control assembly, in the order of numerical sequence in figure 2-34.

2-129. CLEANING.

a. Remove surface dirt or dust by blowing with filtered, low pressure, compressed air.

b. Further clean cover and base assembly with a soft bristle brush moistened with Chlorothene N.U., Federal Specification O-T-620C.

c. Wipe components with a lint free cloth and air dry with filtered, low pressure, compressed air.

2-130. INSPECTION.

a. Inspect base for mounting cover hole bore con dition, stripped and broken cover screws.

b. Inspect all electrical components for evidence of overheating, shorting, and broken terminal lead

c. Inspect insulation of main transistor.

d. Carefully examine variable inductor adjustme socket head. Inspect for broached or broken bore.

e. Inspect harness for signs of burned or broken wires, abrasion and loose connection lugs or terminals.

2-131. TESTING. Refer to Section III for testing the electric governor control unit.

2-132. REPAIR OR REPLACEMENT. Replace a item noted defective during the inspection.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual T.O. 35C2-3-340-14.

2-133. LUBRICATION. No lubrication required

2-134. REASSEMBLY. Reassemble in the reve order of numerical sequence in figure 2-34.

2-135. RADIATOR AND SHUTTER ASSEMBLY.

2-136. SPECIAL TOOLS. No special tools are required for overhaul of the radiator and shutter assembly.

2-137. DISASSEMBLY. Disassemble the radiat and shutter assembly in accordance with figure 2-35.

2-138. CLEANING.

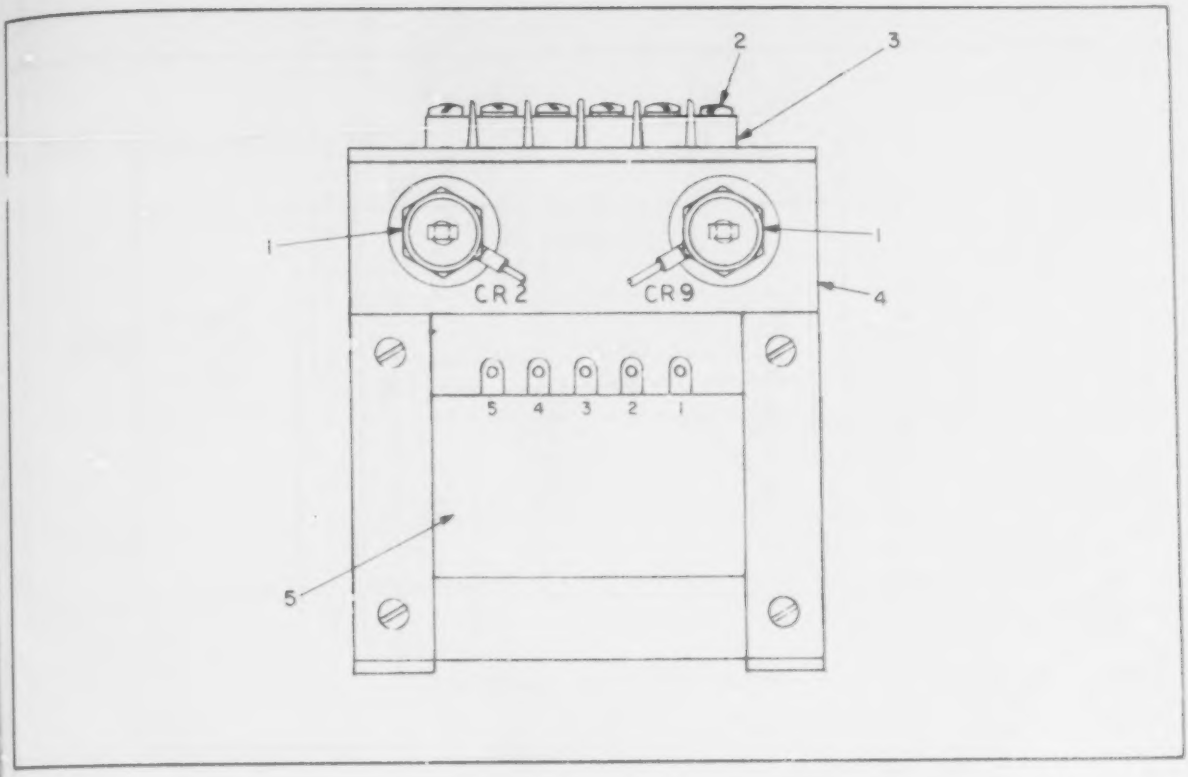
a. Wash painted surfaces with a mild soap an solution. Rinse with clean water. Wipe the su with a clean, damp, lint free cloth. Dry with c filtered, compressed air.

b. Clean all other metal parts with dry clean solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact wi electrical parts.

c. Flush radiator with clean, cool water unt water runs clean.



1. Diode Semiconductor Device
2. Screw, nut
3. Terminal Board
4. Bracket
5. Transformer

Figure 2-27. Transformer Rectifier Assembly

2-139. INSPECTION.

a. Inspect core for damage and corrosion.

b. Check thermal element for proper action.

c. Inspect hose and hose fittings for cracks, corrosion, and other faults that will create leaks.

d. Inspect valve for proper operation.

2-140. TESTING.

2-141. RADIATOR.

a. Cap all water outlets on radiator.

b. Obtain and install proper fitting to connect air pressure line to water inlet pipe.

c. Apply air pressure at 8 psi and check radiator for air leaks.

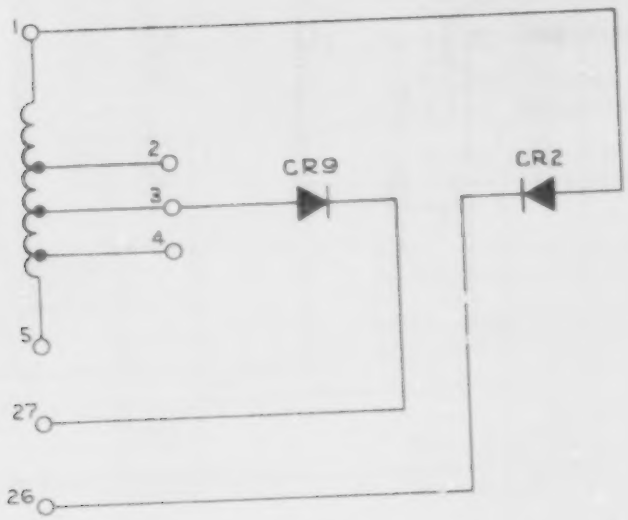
d. Reduce air pressure to 6 psi and paint radiator surfaces and seams with soap and water solution.

e. Check radiator for leaks as evidenced by bubbles.

2-142. SHUTTER MECHANISM.

a. Close shutters. Shutters should begin to open at 55°F. Shutters should be fully open when thermostat ambient temperature reaches 80°F.

b. Check action of assembly linkage for binding during test.



TEST DATA:

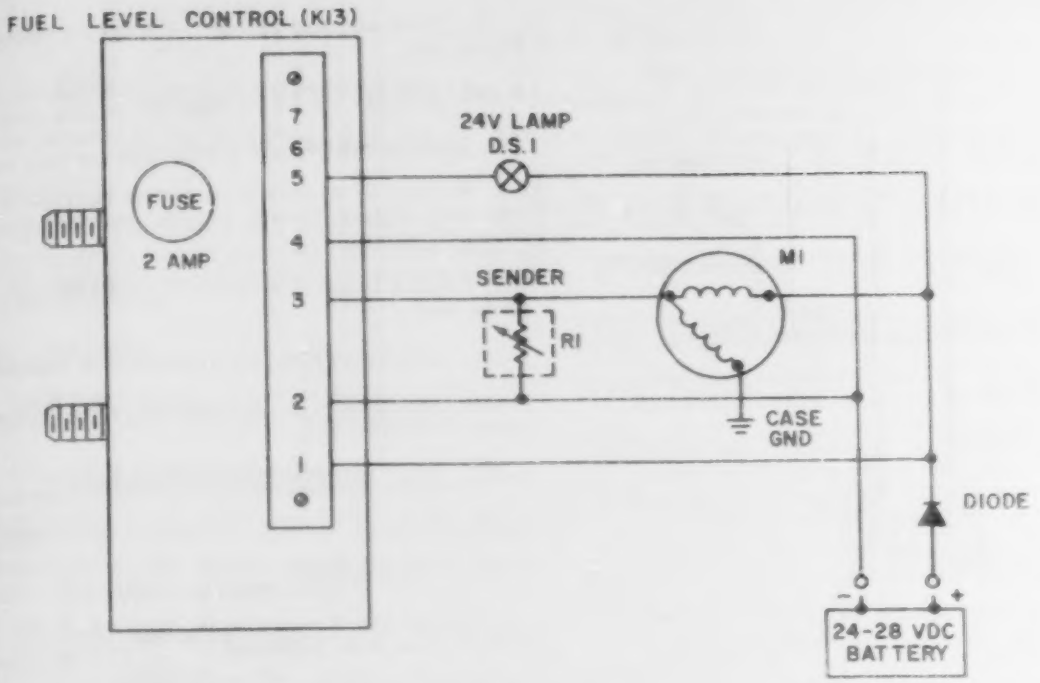
INPUT WINDING 1-5
INPUT VOLTAGE 120V. 60 CPS 1Ø
OUTPUT WINDING & VOLTAGE

1-2	60V. ± 4%
1-3	70V. ± 4%
1-4	80V. ± 4%

NOTE:

TAPS TESTED INDIVIDUALLY WITH 4 AMPS LOAD.

Figure 2-28. Transformer Rectifier Assembly Schematic Diagram



M-1 GAGE FUEL LEVEL
R-1 TANK SENDING UNIT

TEST INSTRUCTIONS:

1. CONNECT FUEL LEVEL CONTROL (K13) TO TEST CIRCUIT AS SHOWN ABOVE.
2. ADJUST TANK SENDER RI FOR "MAX" INDICATION ON FUEL GAGE MI.
3. USING RI TANK SENDER, REDUCE MI READING UNTIL TEST LIGHT DSI GLOWS. (NOTE MI GAGE READING AT THIS POINT - PUMPS B2 AND B3 WILL BE ON)
4. USING RI TANK SENDER, INCREASE MI READING UNTIL TEST LIGHT DSI GOES OUT. (NOTE MI GAGE READING AT THIS POINT - PUMPS B2 AND B3 WILL BE OFF)
5. "PUMPS ON" SHOULD OCCUR BETWEEN 1/4 AND 1/2 AS INDICATED ON MI GAGE.
   "PUMPS OFF" SHOULD OCCUR BETWEEN 3/4 AND FULL AS INDICATED ON MI GAGE.

Figure 2-29. Fuel Level Test Circuit and Instructions

2-143. REPAIR OR REPLACEMENT. To remove corrosion from radiator core, immerse radiator in solution of sulphuric acid, Military Specification O-S-809A (8.60 percent by volume), nitric acid, Military Specification O-N-350 (1.40 percent by volume) and clean water maintained between room temperature and 125°F (52°C) for approximately 30 minutes. Rinse core with clean cold water until acid is removed. Rinse core with hot water at approximately 180°F (82°C) and dry with clean, filtered, compressed air. Repair leaks in radiator core by soldering. Wash off acid after soldering.

2-144. LUBRICATION. No lubrication is required.

2-145. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-146. WINTERIZATION INSTALLATION.

2-147. SPECIAL TOOLS. No special tools are required to overhaul the winterization installation.

2-148. DISASSEMBLY. Disassemble the winterization assembly by following the sequence of index numbers in figure 2-36. (Refer to paragraph 2-155 for overhaul of fuel burning heater assembly).

2-149. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

c. Clean rubber parts with soap and water if these parts have not been treated in accordance with military Specification MIL-H-6000.

d. Flush immersion heater with clean water.

2-150. INSPECTION. Inspect rubber hose, hose and pipe fittings, pipe plugs, etc., for corrosion, cracks, stripped threads, breaks, and tears. Check valve assemblies for freedom of action. Check drain assembly for leaks. Check heater pipe for distortion due to excessive heat. Check flame detector switch quartz rod for cracks.

2-151. TESTING.

a. FUEL BURNING HEATER.

1. Refer to paragraph 2-160 for testing of fuel burning heater.

b. BATTERY BOX TEMPERATURE CONTROL.

1. Close temperature control door. Valve should close at 90°F and reopen at 70°F.

2. Check action of assembly linkage for binding during test.

2-152. REPAIR OR REPLACEMENT.

a. Replace leaking hose assemblies.

b. Replace all winterization system components that have stripped threads, cracks, and other signs of deterioration.

c. Replace immersion heater if it fails to pass above test.

2-153. LUBRICATION. No lubrication is required.

2-154. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-155. FUEL BURNING HEATER ASSEMBLY.

2-156. SPECIAL TOOLS. No special tools required.

2-157. DISASSEMBLY.

a. Remove guard assembly (4, figure 2-37) by releasing two Dzus fasteners.

b. Disconnect lead to terminal No. 6 on terminal board (90).

c. Remove blower assembly (detail A) by bayonet slots mounting screws (9).

d. Turn blower counterclockwise to free bayonet slots and pull straight from housing.

e. Remove louver (5) by removing three screws (6).

f. Loosen compression fittings at both ends of fuel tube assembly (59) and remove.

g. Disconnect leads at terminals 5 and 8 of terminal board (90) and terminal 30 of overheat switch (85). Remove control valve assembly (detail B) by removing four screws (19).

h. Loosen nut (56), disconnect preheat resistor assembly (60), from terminal board (90) and remove resistor assembly fuel tube (63).

i. Using a 13/16 in. deep socket wrench, remove igniter assembly (57). After igniter threads are clear, draw the igniter out of the hatch cover assembly (67). Discard the igniter assembly.

j. Remove five screws (69) that attach the flame detector switch cable assembly (68) to the switch (detail C). Disconnect the other end of the cable assembly from the terminal board (90) and remove the cable assembly.

Disassemble solenoid in the order of index bers 21 through 30.

CAUTION

f disassembled, use a new gasket (30) and ighten screws (25) very carefully. Apply an ven pressure on the valve body. This is a uel seal and leakage will occur from careless reassembly.

. Remove three screws (47), clamp (46), and rmostat (48) to free adapter (49) and orifice plate) with cover (51) and gasket (53). Remove screen) from valve inlet.

58. CLEANING.

. Using a sharp tool, scrape carbon out of the iter pocket. Blow clean with compressed air.

. Combustion residue in the heat exchanger may cleaned with the use of a commercial solvent ch as Oakite (or equivalent) and water. Soak for period of 5 to 10 hours. Drain and rinse thoroughly th fresh water. Be sure to remove all traces of lvent. Dry with compressed air.

c. Clean fuel control valve orifice plate with com- essed air.

d. Completely remove the adjusting screw of the ame detector switch and clean off cement used to al the adjustment.

e. Turn switch over and allow quartz rod to slide ut, being careful not to drop rod.

f. Clean the rod with a clean, dry cloth.

g. Clean the tube of the flame detector switch with wire brush.

h. Clean contacts of overheat switch by sliding a lean strip of bond paper between points. Do not use n abrasive.

i. Blow out heater fuel lines and fuel filter with ompressed air. Clean housing and motor mounting racket in the same manner.

j. Wipe off motor with a clean, dry rag.

k. Clean the guard assembly and housing with ompreesed air, and a clean rag.

l. Remove dirt accumulations from inlet screen with compressed air.

2-159. INSPECTION.

a. Inspect heat exchanger for possible damage and leaks.

b. Inspect orifice plate with a magnifying glass for signs of scores and scratches.

c. Inspect all electrical leads for charred and frayed insulation. Also check for proper connection at soldered points.

d. Inspect quartz rod. It should not be chipped or cracked.

e. Inspect the overheat switch for damage.

f. Check terminal board for cracks and condition of threaded inserts.

g. Inspect condition of weldnuts on housing.

h. Inspect the tube of the flame detector switch for bends, distortion, and other signs of overheating.

2-160. TESTING.

2-161. TEST EQUIPMENT. The following test equipment is required.

a. A source of 24 vdc.

b. A suitable rack or cradle to support the heater in its operating position during test with provision to dispose of the exhaust gases.

c. A test wiring setup similar to the one illustrated in figure 2-38.

d. A fuel tank and electrical fuel pump to supply fuel under pressure to the heater.

e. A flowmeter should be installed in the fuel system to measure fuel flow while the heater is operating. If a flowmeter is not available, it is possible to remove the fuel control valve from the heater and test fuel flow by means of a glass graduate.

f. A strobe light type of tachometer is required to determine speed of the blower motor.

g. An outlet adapter, similar to the one used in the actual heater installation, or a similar device to restrict the ventilating air outlet and provide back pressure will be required when testing.

h. Test continuity through heating element, wiring, and cables with an ohmmeter.

i. The contacts of the thermostat in the fuel control valve open at 70° ±5°F, and may be open at room temperature. Test action of the thermostat contacts by refrigerating unit at 30° ±10°F. Connect at test light to the thermostat contacts and check closing and opening action of contacts between not less than 20°F and not more than 75°F., respectively.

j. Test action of overheat switch using a test light and manually closing contacts.

k. Using an open end wrench, back off the compression nut (82, figure 2-37) of the flame detector switch (detail C) until it clears the boss on the heat exchanger. Pull the switch straight out of the heat exchanger (93) being careful not to bend the tube since it contains a quartz rod that is fragile.

l. Disconnect the wire lead from the overheat switch (85) to terminal 9 of the terminal board (90). Remove the two mounting screws (86) from the weldnuts in the heater housing (95) and remove the switch.

m. Remove nuts and washers (88 and 89), remove wire assembly (87) and install nuts and washers temporarily.

n. Loosen the compression bushing (61) on the fuel tube (63) where it enters the heat exchanger. Remove nut (65) to free terminal (64), hatch cover assembly (67) and fuel tube (63). Remove and discard the wick (58).

NOTE

The bushing (61) and compression collar (62) are tightly clinched on the fuel tube. There is no reason to remove these parts unless they are damaged. Once removed however, always use a new collar on fuel tube.

o. Remove terminal board (90) by removing four screws (91). Remove designation plate (92).

p. Remove heater housing (95) from heat exchanger (93), remove three screws (94), stand the assembly on end and spread the housing so that the heat exchanger will slide out. Leave identification plate (7) on housing unless necessary to replace.

CAUTION

To prevent permanent distortion of housing (95), do not spread the seam any more than is necessary to remove heat exchanger (93).

q. Remove three motor mounting bracket screws (13) from the housing (12) and remove the motor and mounting bracket. Loosen the setscrew in the ventilating blower wheel hub and remove the wheel (14).

r. Mark the position of the motor mounting bracket (18) on the motor (15) and then loosen mounting bracket screws (16) and remove motor. Discard grommet (10) after removal from the housing.

NOTE

The following steps provide a disassembly procedure for the fuel control valve. However, test the valve prior to disassembly in accordance with the test procedure.

s. Disassemble the pressure regulator side of the valve in order of index numbers 31 through 41.

CAUTION

Use clean tools and work on a clean surface when making valve repairs. It is important that the entry of foreign matter be prevented since it may cause clogging of the needle valve or cause leakage at the solenoid valve seating surface.

t. If the diaphragm cap (36) is removed, install new gasket (41).

u. Do not remove valve assembly (42) unless absolutely necessary. The screen (44) need not be replaced unless the inlet screen (54) shows evidence of clogging or gum formation. If it is necessary to remove the valve, use a socket wrench or box wrench. Install a new screen (44) and gaskets (43) if the valve is removed. Tighten the valve carefully and do not use excessive torque which may distort the body.

Legend To Figure 2-30

1. Top Cover
2. Battery Jumper Cable Assembly
3. Battery Neg. Cable Assembly
4. Battery Pos. Cable Assembly
5. Hose Clamp
6. Rubber Hose
7. Screw, Lockwasher, Flatwasher, Nut
8. Thermostatic Switch
9. Plain Hex. Nut
10. Flat Washer
11. Hook Bolt
12. Hold Down Center Bracket
13. Hold Down Side Bracket
14. Battery
15. Screw, Lockwasher, Flatwasher, Nut
16. Electrical Heating Element
17. Grommet
18. Grommet
19. Battery Box Shell

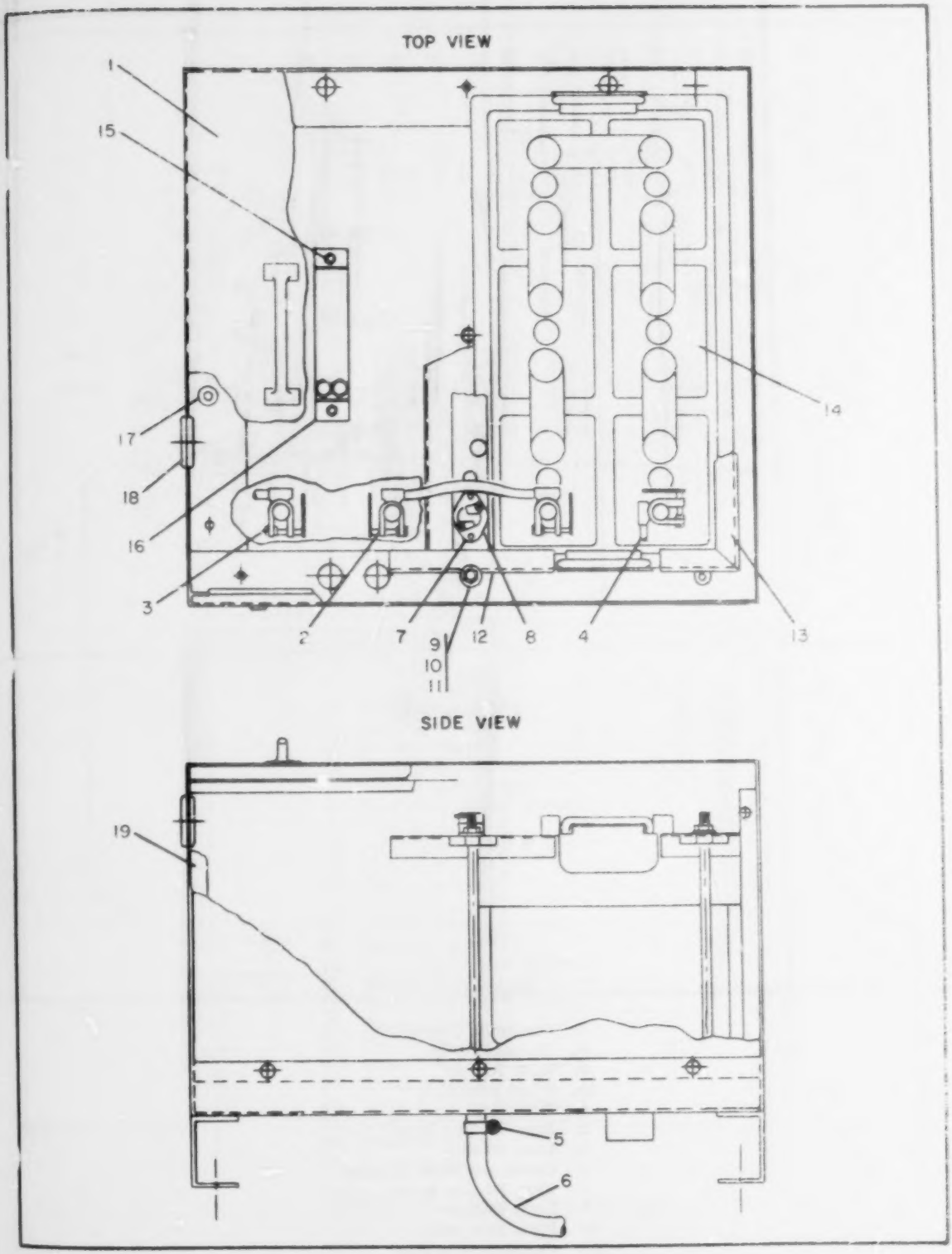
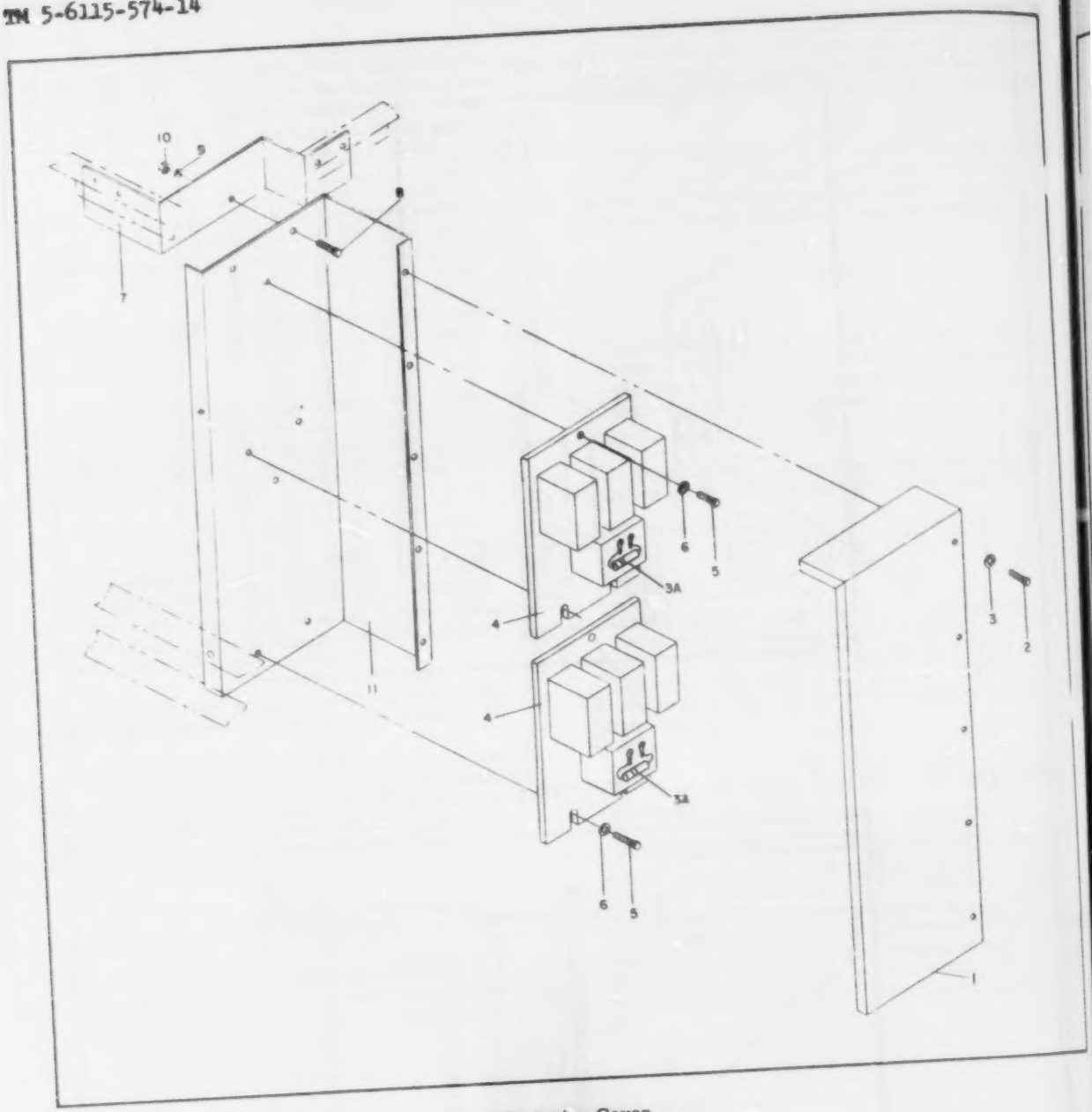
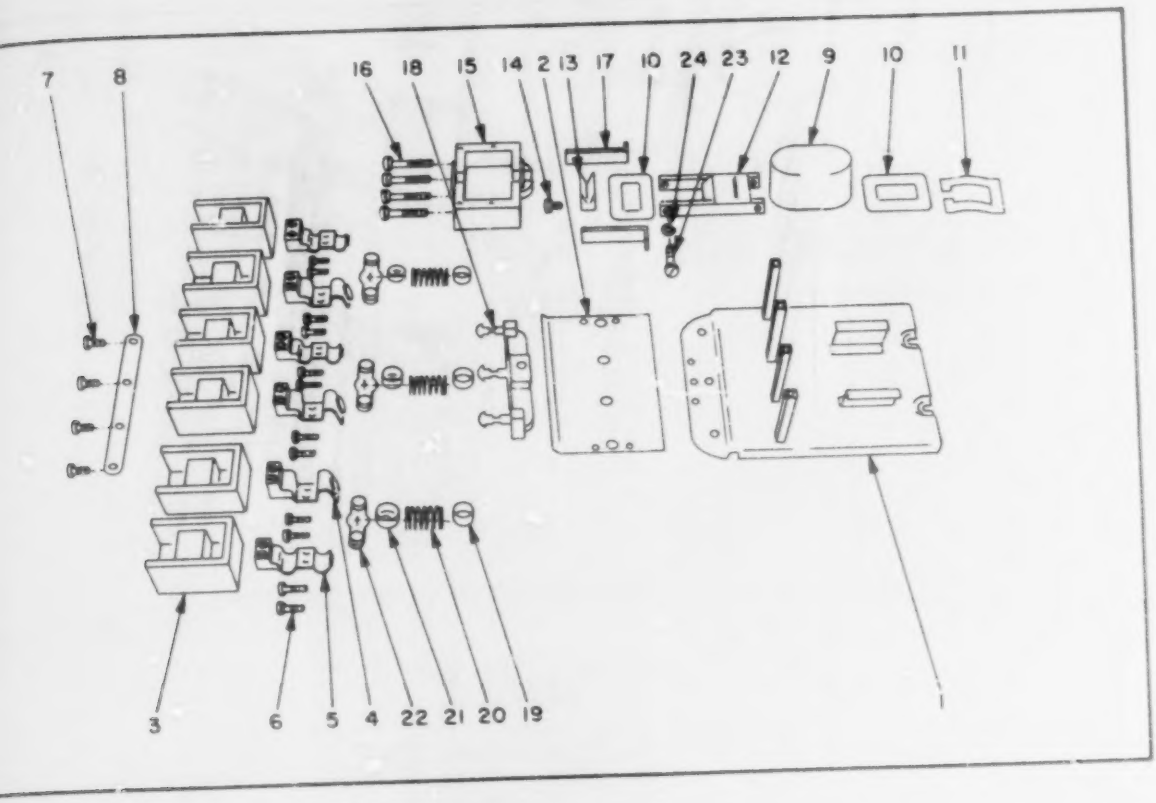


Figure 2-30. Battery Box Assembly



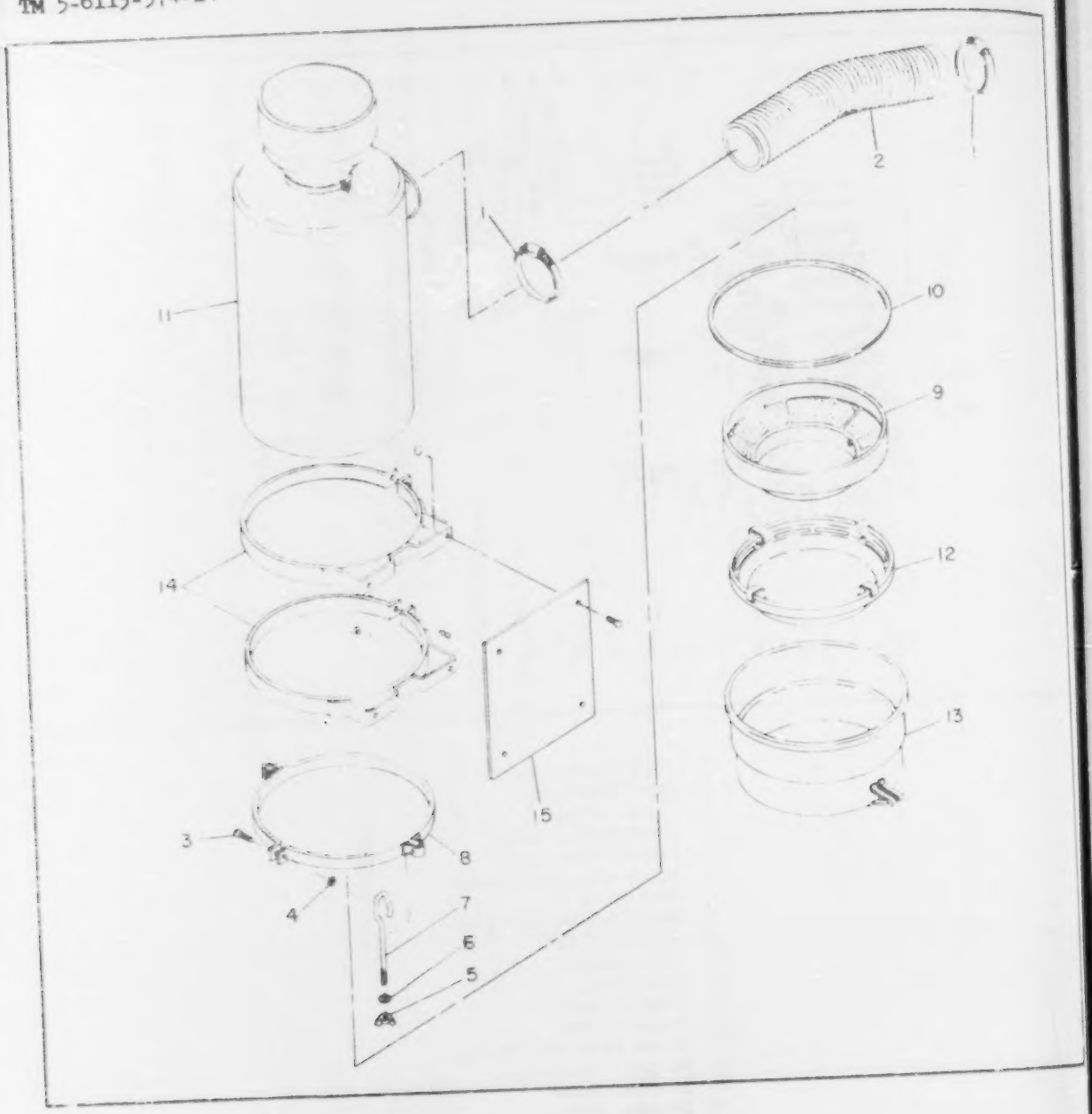
1. Contactor Cover
2. Machine Screw
3. Lock Washer
3A. Diode Assembly
4. Contactor
5. Hex. Hd Cap Screw
6. Lock Washer
7. Contactor Panel Bracket
8. Hex. Hd Cap Screw
9. Lock Washer
10. Plain Hex. Nut
11. Contactor Chassis

Figure 2-31. Contactor Installation



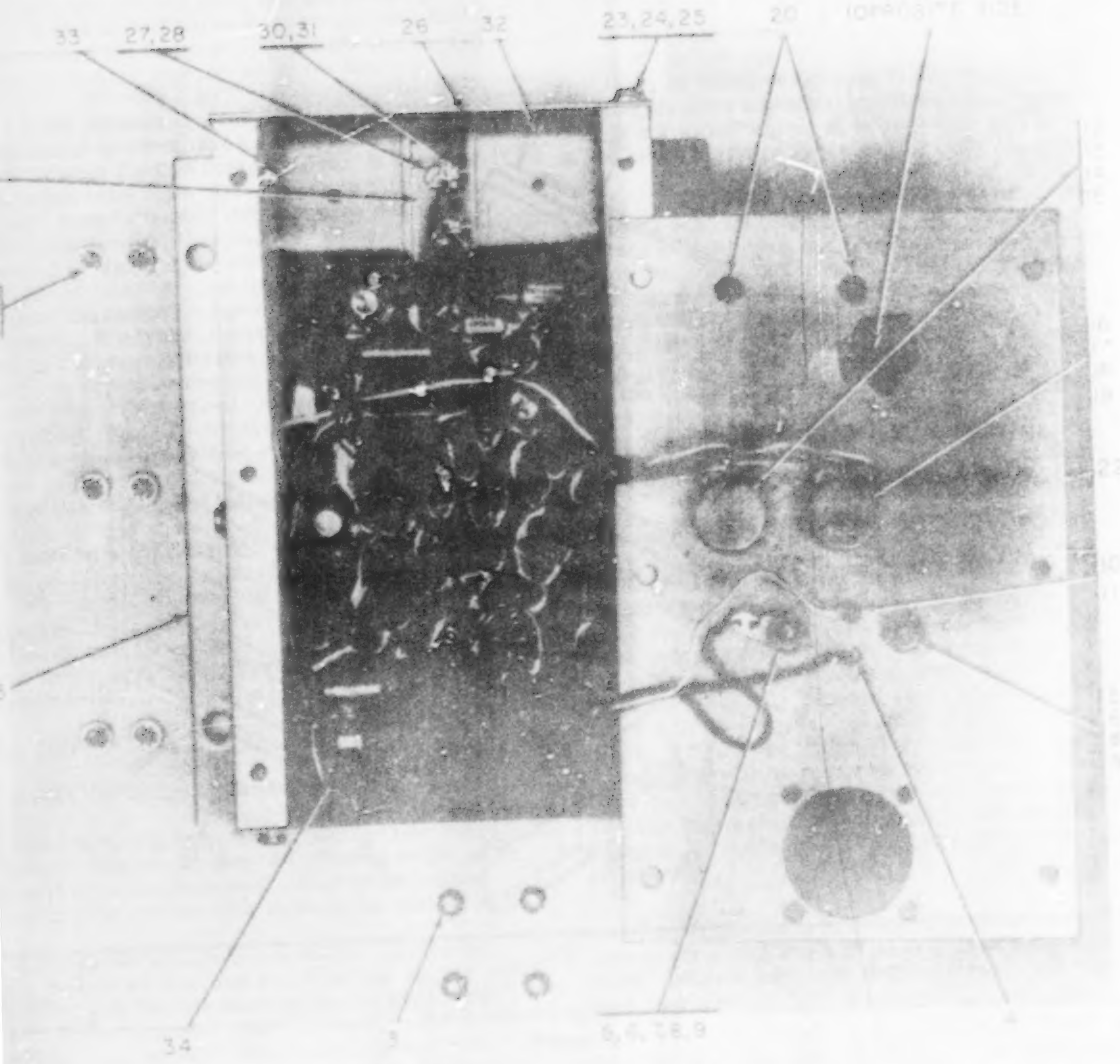
1. Panel Contact Assy.
2. Panel Insulator
3. Contacts Hood
4. Fixed Contact Assy.
5. Fixed Contact Assy.
6. Screw Assembled Washer
7. Hood Strap
8. Screw Assembled Washer
9. 12 Volt DC Coil
10. Coil Insulator
11. Coil Clamp
12. Plunger Assy.
13. Magnetic Stop
14. Screw Assembled Washer
15. Magnet Frame Assy.
16. Machine Screw
17. Plunger Guide
18. Contact Support
19. Contact Spring Barrier
20. Contact Spring
21. Contact Spring Barrier
22. Contact Bar Assy.
23. Machine Screw
24. Lock Washer

Figure 2-32. Contactor Assembly



1. Hose Clamp
2. Flexible Hose
3. Machine Screw
4. Hex Plain Nut
5. Plain Wing Nut
6. Concave Washer
7. Hook Bolt
8. Retaining Band
9. Prefilter
10. Rubber Gasket
11. Air Cleaner Body
12. Disk
13. Cup
14. Bracket
15. Mtg Plate

Figure 2-33. Air Cleaner Assembly

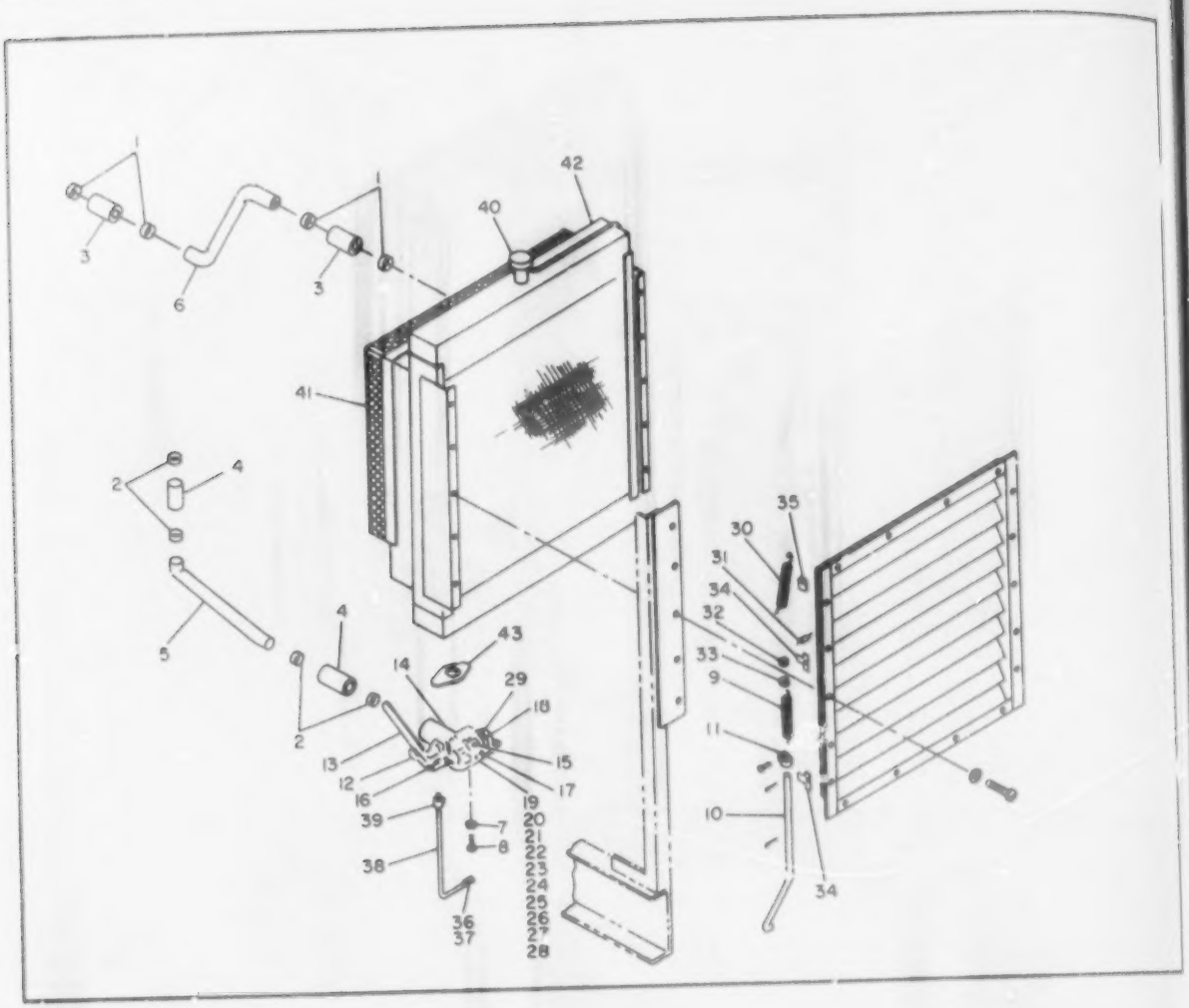


Screw
Washer
Screw
Insulation Tubing
Nut
Lock Washer
Terminal
Insulation Bushing
Screw
Transistor
Transistor Insulation
Lock Nut

13. Mounting Nut
14. Lock Washer
15. Variable Resistor
16. Lock Nut
17. Mounting Nut
18. Lock Washer
19. Variable Resistor
20. Plug
21. Nameplate
22. Cover
23. Screw
24. Lock Washer

25. Flat Washer
26. End Plate
27. Screw
28. Lock Washer
29. Bracket
30. Screw
31. Lock Washer
32. Variable Inductor
33. Variable Inductor
34. Control Unit Board Assembly
35. Base

Figure 2-34. Electric Governor Control Assembly



1. Hose Clamp
2. Hose Clamp
3. Hose
4. Hose
5. Lower Radiator Tube
6. Upper Radiator Tube
7. Lockwasher
8. Screw
9. Spring
10. Control Rod
11. Guide Block
12. Lever
13. Lever
14. Spring
15. Pin
16. Shaft
17. Plunger
18. Yoke
19. Flange
20. Thermostat
21. Gasket
22. Nut
23. Packing Preformed
24. Spring
25. Seat
26. Seat
27. Felt
28. Retaining Ring
29. Housing
30. Spring
31. Pin
32. Bushing
33. Bushing
34. Guide
35. Clip
36. Coupling
37. Plug
38. Tube
39. Valve
40. Cap
41. Fan Guard Assembly
42. Radiator
43. Gasket

Figure 2-35. Radiator and Shutter Assembly

2. The fuel flowmeter should be installed in the line between the fuel pump and the heater assembly. A fuel shutoff valve must be included near outlet end of the fuel line. A flexible section will elpful in making connections to the heaters.

33. In the absence of a flowmeter, a glass duate and stop watch may be used to determine flow through the fuel control valve. It is necesy to remove the valve when testing in this manner when carefully timed, this test provides an urate check on fuel flow and may be used to check owmeter of doubtful accuracy. The source of ect current must be capable of continuous operas without excessive change in voltage with varias in load. If a transformer and rectifier are d without storage batteries, it will usually be essary to provide some means of regulating volt- at the heater test panel. A bank of storage baties without regulation should be satisfactory, vided the charging rate is sufficient to keep teries in fully charged condition and wiring is of fficient size to prevent an excessive voltage drop the line. In any system, an ammeter and voltter must be provided at the test panel to indicate al current drawn and applied voltage during the t. The control switches, meters, flowmeter, and ltage regulator should be mounted in a group on e panel so that all can be used at one time. An ctric timer is also useful, but a stop watch can used instead.

164. BURN TEST.

a. Install the heater on the test bench.

b. Make fuel, electric, and exhaust connections to e heater. The heater must be mounted in the same osition it normally occupies, since the mounting osition affects the fuel flow through the control valve.

c. If the power source is adjustable, preset the oltage control by trial and error so that voltage will e 24 volts with the full starting load of the heater. f a nonadjustable power supply is used, make sure he voltage is at least 22 volts under starting conditions. The test will not be valid unless starting oltage is within these limits, since ignition time is ffected by voltage.

d. With the above conditions established, set the ontrol switch to ON. Start timing heater operation rom the instant the switch is turned on.

e. Current draw must not exceed 17 amperes.

f. The heater should ignite within 40 seconds.

g. The flame detector switch must transfer within 2.5 minutes from the moment the heater control switch is turned on.

NOTE

Ignition may be inaudible. If so, transfer time of the flame detector switch will be used as the limiting factor for test.

h. Observe fuel flow on the flowmeter. Flow must be more than 0.037, but less than 0.047 lb. min.

i. If fuel rate is not within limits, turn adjusting screw of the fuel control valve clockwise to increase fuel flow, or counterclockwise to decrease flow and retest. If, after adjusting fuel flow, it is found that flow is not within limits, it is an indication that one of the metering holes in the orifice plate is clogged.

2-165. OVERHEAT TEST. To test overheat switch, gradually restrict the ventilating air flow at the outlet until the switch opens and the heater stops operating. Opening time is noncritical, so long as the switch opens when the ventilation air flow is restricted. Replace the switch if it fails to operate.

2-166. PURGE TEST. With the heater operating turn the heater control switch off. Fuel flow must drop to zero immediately. The blower must continue to run for more than one minute, but less than 3-1/2 minutes, and must then automatically stop. Reset, or replace, the flame detector switch if not within limits.

2-167. TESTING FUEL CONTROL VALVE. If a flowmeter is not available to test fuel flow, the fuel control valve can be removed from the heater and tested separately by measuring the amount of fuel which passes through the valve in a specified time. The fuel control valve must be tested in its actual operating position. The test setup illustrated in figure 2-39 is suitable. In addition to the tubing shown, a 50 or 100 cc. glass graduate with accurate calibrations will be required. A fixture to hold the valve should be provided. Two test leads with alligator clips and a panel switch must be provided to energize the solenoid. To test fuel flow proceed as follows:

a. Mount the valve in the holding fixture and connect the fuel line and test leads according to figure 2-39. Place a container under the valve and apply fuel pressure.

b. Turn on the switch to energize the solenoids and permit fuel to flow for a few seconds until conditions are stabilized, then place the graduate under the outlet tube and start timing flow. One minute can be used as a timing interval if the graduate has sufficient capacity.

c. Turn the solenoid switch off at the end of the timing interval and place the graduate on a flat surface to read the contents. The amount of fuel must be within the limits shown in Table 2-1. If fuel flow is not within limits, turn the adjusting screw clockwise to increase flow or to reduce flow. Recheck flow after adjusting.

d. After flow has been brought within limits, it will be necessary to clean or replace the orifice plate and then test and readjust the valve. Repair or replace the valve if this does not correct the condition.

Legend To Figure 2-36

1. Hose Clamp
2. Rubber Hose
3. Hose Clamp
4. Rubber Hose
5. Rubber Hose
6. Pipe Nipple
7. Engine Adapter Plate
8. Rubber Hose
9. Drive Screw
10. Identification Plate
11. Hose Clamp
12. Coupling Hose
13. Oil Vapor Valve Assembly
14. Hose Clamp
15. Pipe Elbow
16. Oil Pan Heater Pipe
17. Loop Clamp
18. Straight Adapter
19. Pipe Plug
20. Hose Assembly
21. Gate Valve
22. Elbow
23. Clamp
24. Pipe Nipple
25. Pipe Tee
26. Pipe Nipple
27. Bushing
28. Electric Immersion Heater
29. Pipe Nipple
30. Pipe Nipple
31. Pipe Bushing
32. Pipe Tee
33. Lock Nut
34. Flat Washer
35. Nonmetallic Washer
36. Iron Pipe
37. Primer Pump
38. Hex. Hd Cap Screw
39. Tubing
40. Fitting
41. Tubing
42. Elbow
43. Nozzle
44. Hex. Hd Cap Screw
45. Lock Washer
46. Hex. Plain Nut
47. Mtg Bracket
48. Screw, Lockwasher, Nut
49. Ground Strap
50. Engine Bond Strap
51. Hex. Hd Cap Screw
52. Lock Washer
53. Hex. Plain Nut
54. Fuel Burning Heater Assembly
55. Screw, Lockwasher, Nut
56. Mtg Bracket
57. Hose Clamp
58. Elbow
59. Machine Screw
60. Hex. Hd Cap Screw
61. Hex. Hd Cap Screw
62. Temperature Control

Legend To Figure 2-37

1. Retaining Band
2. Mtg Bracket
3. Outlet Adapter
4. Guard Assembly
5. Louver
6. Machine Screw
7. Identification Plate
8. Rivet
9. Machine Screw
10. Grommet
11. Machine Screw
12. Blower Housing
13. Machine Screw
14. Blower Wheel Assembly
15. Motor
16. Hex. Hd Cap Screw
17. Washer
18. Mtg Bracket
19. Machine Screw
20. Coil Assembly
21. Machine Screw
22. Lock Washer
23. Flat Washer
24. Solenoid Cup
25. Machine Screw
26. Core Assembly
27. Compression Helical Spring
28. Valve Seal
29. Solenoid Plunger
30. Gasket
31. Adjusting Screw
32. Cable Assembly
33. Heating Element
34. Hex Plain Nut
35. Stud Terminal
36. Diaphragm Cap
37. Machine Screw
38. Spring Seat
39. Compression Helical Spring
40. Diaphragm Assembly
41. Gasket
42. Valve Assembly
43. Gasket
44. Screen
45. Cable Assembly
46. Thermostat Clamp
47. Machine Screw
48. Thermostat
49. Mtg Adapter
50. Gasket
51. Orifice Plate Cover
52. Orifice Restriction Plate
53. Gasket
54. Inlet Screen
55. Valve Body
56. Self Locking Nut Hex. Hd
57. Igniter Assembly
58. Wick
59. Fuel Tube Assembly
60. Resistor Assembly
61. Compression Bushing
62. Compression Collar
63. Fuel Tube
64. Lug Terminal
65. Hex. Self Locking Nut
66. Lock Washer
67. Hatch Cover Assembly
68. Flame Detector Switch Cable Assy
69. Machine Screw
70. Machine Screw
71. Lock Washer
72. Switch
73. Machine Screw
74. Lock Washer
75. Flat Washer
76. Hex Plain Nut
77. Adjusting Screw
78. Flat Washer
79. Spring Tension Clip
80. Switch Bracket
81. Quartz Rod
82. Nut
83. Sleeve
84. Bracket and Tube Assembly
85. Overheat Switch
86. Machine Screw
87. Wire Assembly
88. Hex. Plain Nut
89. Lock Washer
90. Terminal Board
91. Machine Screw
92. Designation Plate
93. Exchanger Heat
94. Machine Screw
95. Heater Housing

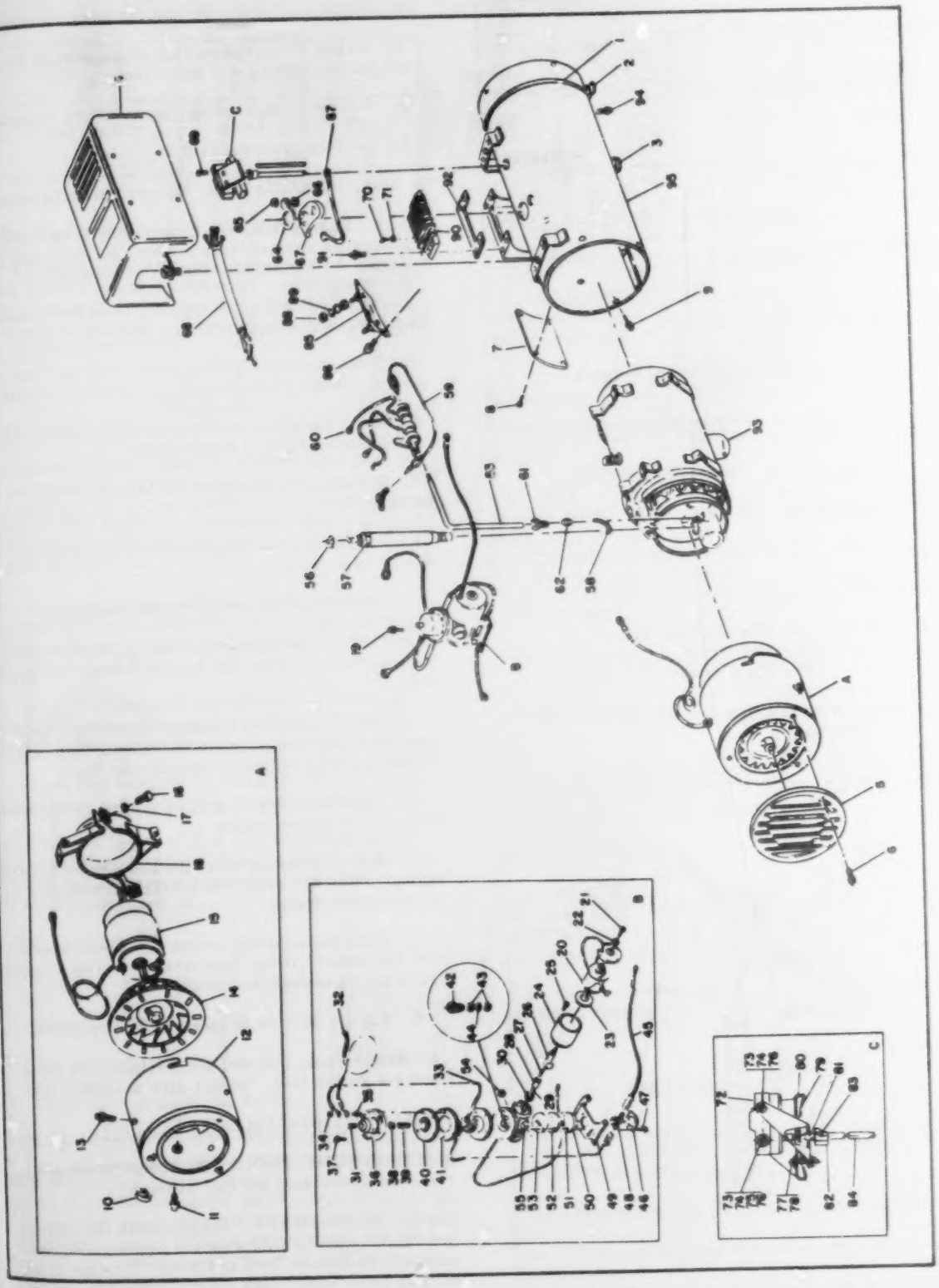


Figure 2-37. Fuel Burning Heater Assembly

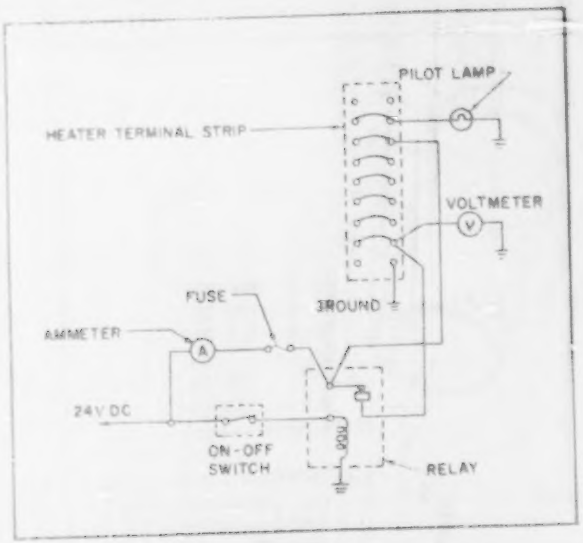


Figure 2-38. Heater Test Wiring

2-168. IMMERSION HEATER TEST. Using an ohmmeter, a thermometer and a heated oil pot, test the immersion heater together with the lubricating oil heater switch S21. Contacts of switch should open at 160°F and close at 155°F.

2-169. REPAIR OR REPLACEMENT.

a. Replace igniter at each overhaul interval.

b. Replace wick (58, figure 2-37) at each overhaul interval.

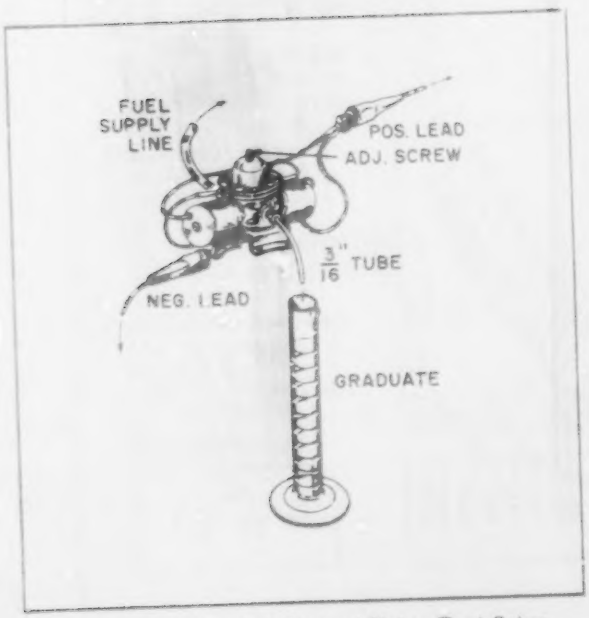


Figure 2-39. Fuel Control Valve Test Setup

c. Replace all defective and damaged components.

d. Do not attempt repair or adjustment of the overheat switch. Replace if defective.

e. Replace compression collar (62) as required.

f. Replace grommet (10).

2-169A. LUBRICATION. No lubrication is required.

2-170. REASSEMBLY. Reassembly is essentially the reverse of disassembly. Note the following precautions during the reassembly procedure.

a. When replacing the igniter, start the threads by hand and then tighten with a wrench.

b. If compression bushing and collar have been removed, install a new collar and clinch as required.

c. When installing motor mounting bracket, adjust to position marked in disassembly.

d. Install a new grommet (10) in the blower housing.

e. Reassemble and adjust the flame detector switch as follows:

1. Insert quartz rod into expansion tube.

2. Insert bow spring and turn microswitch back into position until the bow spring touches the quartz rod.

3. Reassemble the adjusting screw and turn it clockwise until the microswitch clicks; then back the adjusting screw off approximately one turn.

4. Tighten mounting screws so that the switch is held firmly but not locked.

5. Remove tension from the bow spring by pressing up. This will allow the quartz rod to center itself on the switch button.

6. Turn the adjusting screw clockwise slowly until the switch clicks; then turn the screw clockwise 3/4 of a turn beyond this point.

7. Tighten screws to lock switch in position.

f. Remove nuts (88) and lockwashers (89) from overheat switch (85). Install wire assembly (87).

2-171. FUEL SYSTEM INSTALLATION.

2-172. SPECIAL TOOLS. No special tools are required to overhaul the fuel system.

2-173. DISASSEMBLY. Disassemble the fuel system installation by following the sequence of index numbers in figures 2-40 and 2-41. Be sure to tag all fuel lines so that they may be properly reassembled.

Table 2-1. Fuel Flow Chart

Fuel Rate LB/MIN	DFA	DFI	Gasoline	JP4	CIE	Kerosene
0.042 ±0.005	23 ±3	24 ±3	25 ±3	25 ±3	24 ±3	24 ±3

4. CLEANING.

Clean external dirt, oil, grease, etc. from the al parts of the fuel system with a bristle brush has been dipped in cleaning solvent, Federal ification P-S-661. Rinse with solvent and then with compressed air.

CAUTION

Cleaning solvent, Federal Specification P-S-661 should not be allowed to come in contact with rubber hoses, boots, gaskets, etc. as it will deteriorate rubber not specially treated in accordance with Military Specification MIL-H-6000.

. Immerse valves, elbows, connectors, and mbing in cleaning solvent, Federal Specification S-661. Rinse in fresh cleaning solvent and dry h compressed air.

. Clean and flush all fuel lines and hoses with aning solvent, Federal Specification P-S-661. y with compressed air.

. Wash fuel strainer in cleaning solvent, Federal ecification P-S-661. Dry with compressed air.

. Wipe out inside of fuel tank with a lint free th soaked in cleaning solvent, Federal Specification P-S-661. Rinse in fresh cleaning solvent and y with compressed air.

175. INSPECTION.

. Examine valves for free action.

. Examine rubber hose for cracks.

. Inspect fuel tanks for leaks.

. Check fuel strainer for tears.

176. TESTING. Using a test source of variable l vdc, test operation of fuel burning heater solenoid d auxiliary fuel pump. Pump should start to erate and solenoid should start to pull in at 18 vdc. est fuel tank by capping outlets, painting surfaces ith soap and water solution and applying air pressure at 6 psi to inlet port. There should be no vidence of cracks or openings in the tank.

2-177. REPAIR OR REPLACEMENT.

a. Replace leaking hose assemblies.

b. Replace all fuel system components that have stripped threads, cracks, and other signs of deterioration.

c. If the fuel strainer is torn or otherwise damaged, replace it.

d. Repair tank by welding any cracks or separated welds.

e. Remove minor nicks, burrs, or scores with crocus cloth, Federal Specification P-C-458.

2-178. LUBRICATION. No lubrication is required.

2-179. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-180. LOAD AND RECONNECTION ASSEMBLY.

2-181. SPECIAL TOOLS. No special tools are required to overhaul the load and reconnection assembly.

2-182. DISASSEMBLY. Disassemble the load and reconnection assembly by following the sequence of index numbers in figure 2-42.

2-183. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered compressed air.

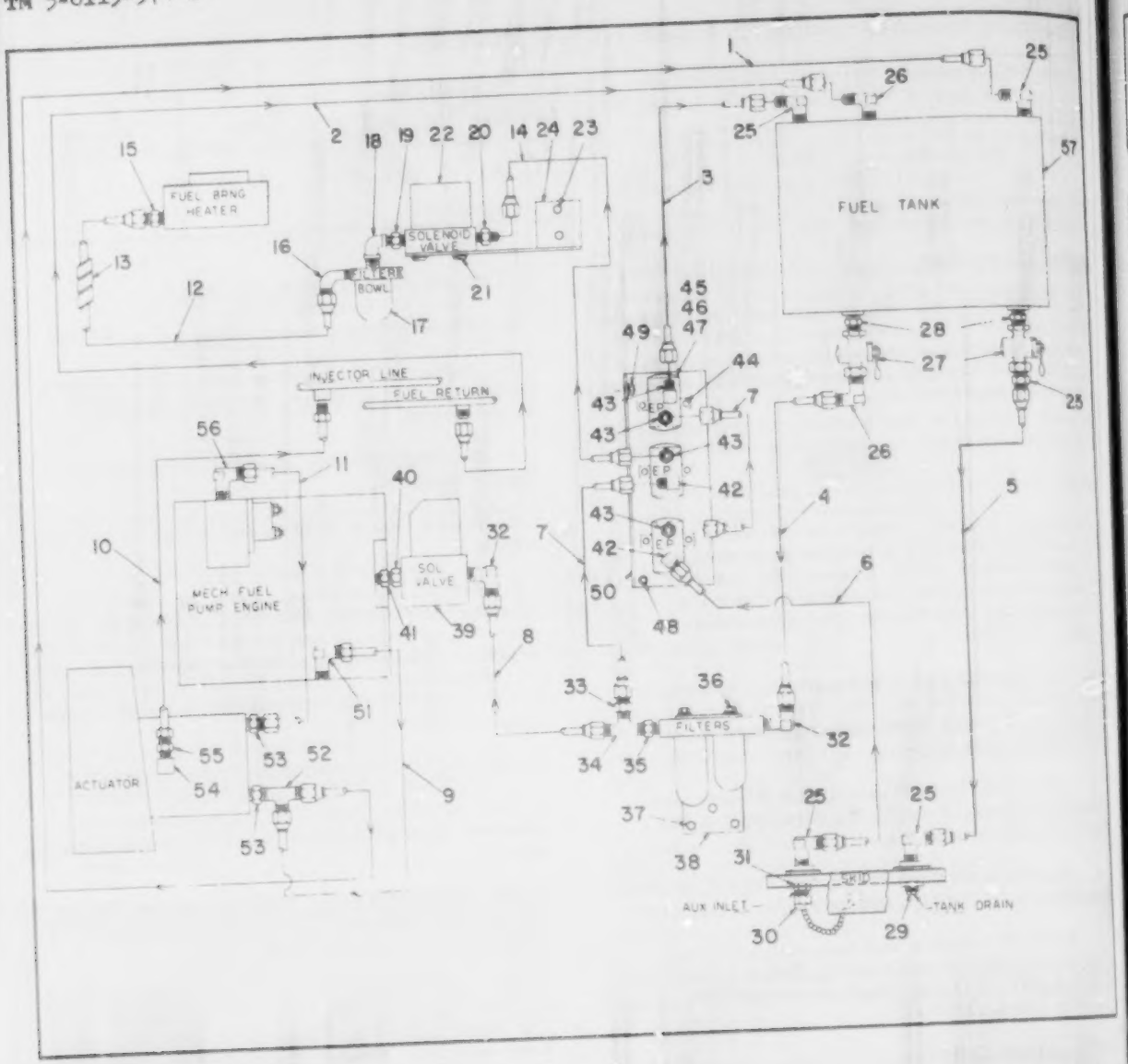
b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

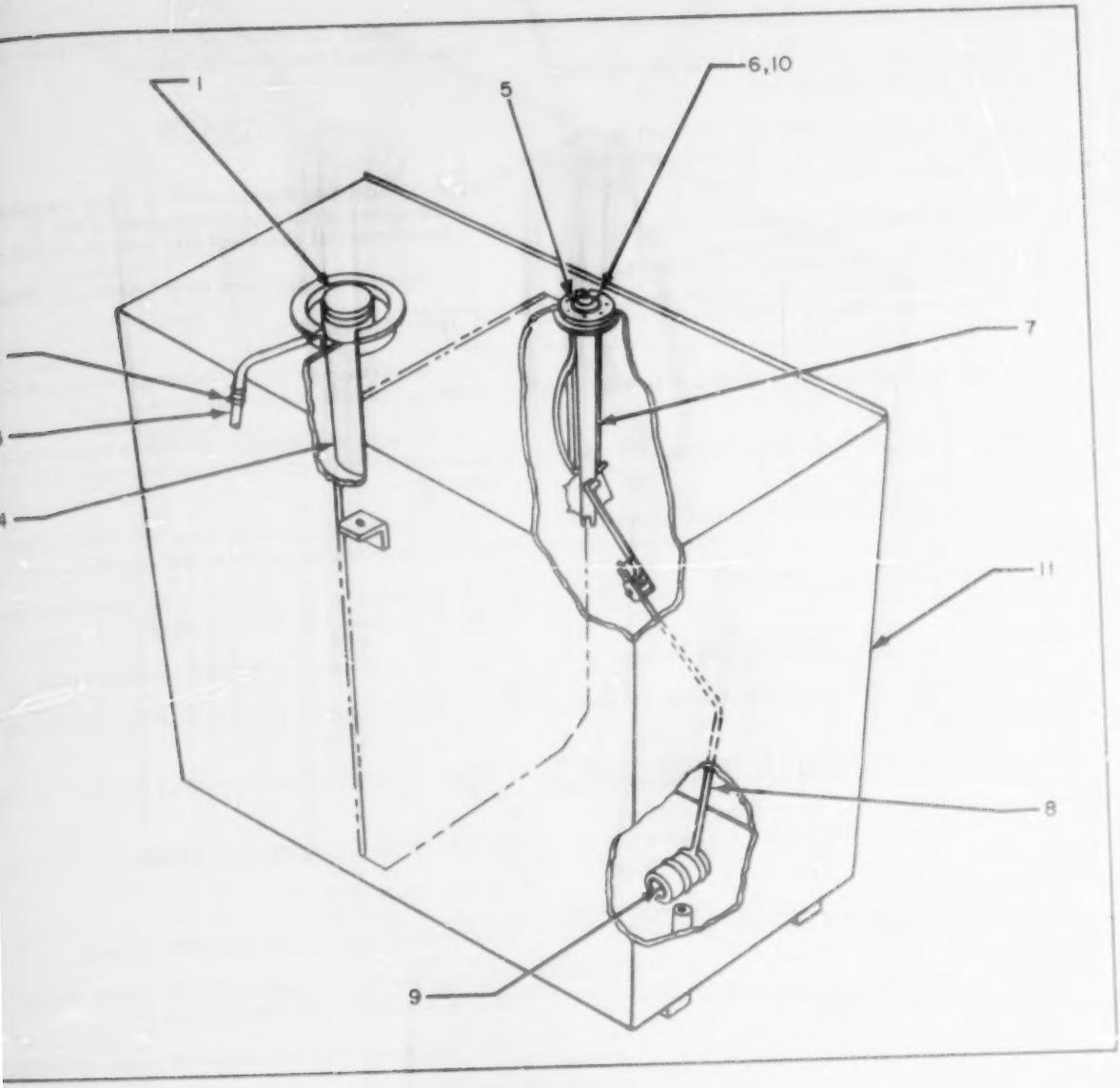
c. Clean electrical parts with a soft bristle brush.

d. Clean and burnish terminals and contacts when necessary.



1. Hose Assembly
2. Hose Assembly
3. Hose Assembly
4. Hose Assembly
5. Hose Assembly
6. Hose Assembly
7. Hose Assembly
8. Hose Assembly
9. Hose Assembly
10. Hose Assembly
11. Hose Assembly
12. Hose Assembly
13. Plastic Sleeve
14. Hose Assembly
15. Connector
16. Elbow
17. Fuel Strainer
18. Elbow
19. Nipple
20. Connector
21. Machine Screw
22. Solenoid
23. Hex. Hd Cap Screw
24. Bracket
25. Elbow
26. Elbow
27. Shut Off Valve
28. Bushing
29. Bushing
29. Pipe Plug
30. Cap and Chain
31. Connector
32. Elbow
33. Adapter
34. Tee
35. Bushing
36. Hex. Hd Cap Screw
37. Hex. Cap Screw
38. Bracket
39. Solenoid Valve
40. Bushing
41. Nipple
42. Elbow
43. Connector
44. Screw, lockwasher, nut
45. Electrical Pump
46. Filter Element
47. Gasket
48. Bolt, lockwasher, nut
49. Bolt, lockwasher, nut
50. Fuel Pump Bracket
51. Elbow
52. Tee
53. Adapter
54. Elbow
55. Connector
56. Elbow
57. Fuel Tank Assy.

Figure 2-40. Fuel System



1. Filler Fuel Tank Cap
2. Hose Clamp
3. Rubber Hose
4. Fuel Strainer
5. Screw, lockwasher
6. Sending Unit Assy.
7. Transmitter Liquid Quantity
8. Float Arm
9. Float
10. Gasket
11. Fuel Tank

Figure 2-41. Fuel Tank Assembly

2-184. INSPECTION.

a. Inspect transformers for signs of overheating and worn or frayed insulation.

b. Check bus bars, connectors, terminal boards, and transformer terminals for evidence of pitting and carbon deposits due to arcing.

c. Check hardware for stripped threads.

2-185. TESTING. Use standard continuity test procedures to check resistors and transformers. Test value of capacitors. To test field flashing relay proceed as follows:

1. Relay coil terminals are identified by blue beads.

2. Connect relay coil terminals across ±24 vdc source.

3. Using an ohmmeter assure contacts open and close.

2-186. REPAIR OR REPLACEMENT. Replace defective components.

2-187. LUBRICATION. No lubrication is required.

2-188. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-189. ALTERNATING CURRENT GENERATOR.

2-190. SPECIAL TOOLS. No special tools are required to overhaul the alternating current generator.

2-191. DISASSEMBLY. Disassemble the alternating current generator in accordance with figure 2-43. Note the following.

a. Disconnect the label all exciter leads from leads entering generator shaft.

b. Disconnect exciter rotor leads from fan and label.

c. Disconnect regulator cable and label.

d. Use a bearing puller to remove bearing, exerting even pressure on the bearing race.

2-192. CLEANING.

a. Clean dirt and grease from interior and exterior components with a bristle brush that has been dipped in cleaning solvent, Federal Specification P-S-661.

b. Vacuum the stator and rotor windings to remov dirt, dust and other foreign matter.

CAUTION

Avoid using compressed air to clean the rotor and stator since this method may result in blowing metal chips and dirt into the insulation.

c. Remove oil lubricant from lubrication fittings.

2-193. INSPECTION.

a. Inspect condition of windings, leads, and insulation. Examine for burned coils.

b. Be sure windings are secure in supporting slo Check supporting ties by examining rigidity of coil end turns.

c. Check bearings, bushings, and coupling disk for excessive wear, scores, and burrs.

d. Examine surge protectors for signs of overhe ing, loose tape, and charred thyrites.

e. Check for bent or warped coupling discs.

f. Check rotor for loose insulating material and wires.

2-194. TESTING. Perform tests indicated in tab 2-2.

2-195. REPAIR OR REPLACEMENT.

2-196. GENERAL.

a. Repair broken and open leads to coils.

b. Replace burned and damaged coils and coils failing standards specified in table 2-2.

c. Replace defective diodes and surge protecto

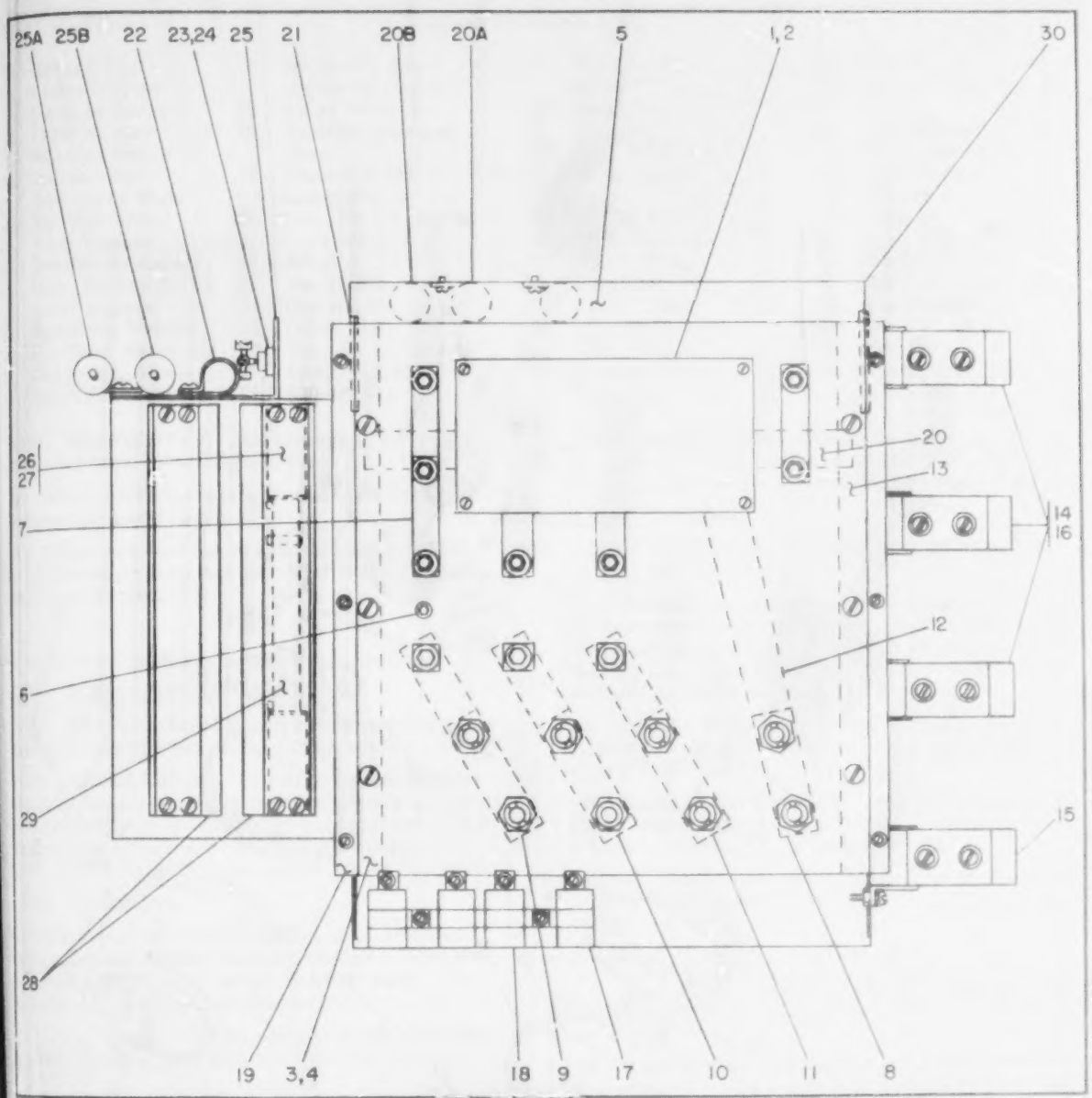
d. If generator field is open or shorted, replac complete rotor assembly including shaft and coup

e. Replace generator bearing at each overhaul interval.

f. Replace damaged coupling disc.

2-197. GENERATOR REBUILD INFORMATION. Refer to table 2-3 for generator rebuild informa

2-198. LUBRICATION. Pack new bearing with grease, Military Specification MIL-G-10924, pr to reassembly. Pack grease cup with identical grease as required.



Legend To Figure 2-42

1. Machine Screw
2. Identification Plate
3. Screw, Lockwasher, Flatwasher
4. Panel Cover
5. Cover Plate
6. Stud Terminal
7. Bus Bar
8. Service Connector
9. Load Bus Bar
10. Load Bus Bar
11. Load Bus Bar
12. Neutral Bus Bar
13. Mounting Panel
14. Current Transformer
15. Cross Current Transformer
16. Mounting Angle Bracket
17. Capacitor
18. Capacitor
19. Cover Mounting Bracket
20. Terminal Board
20A. Capacitor
20B. Capacitor
21. Rubber Extrusion
22. Clamp
23. Blocking Diode and Heat Sink Assembly
24. Diode
25. Heat Sink
25A. Capacitor
25B. Capacitor
26. Screw, Lockwasher Flatwasher, Nut
27. Terminal Board
28. Designation Plate
29. Resistor Assembly
30. Mounting Bracket

Figure 2-42. Load and Reconnection Assembly

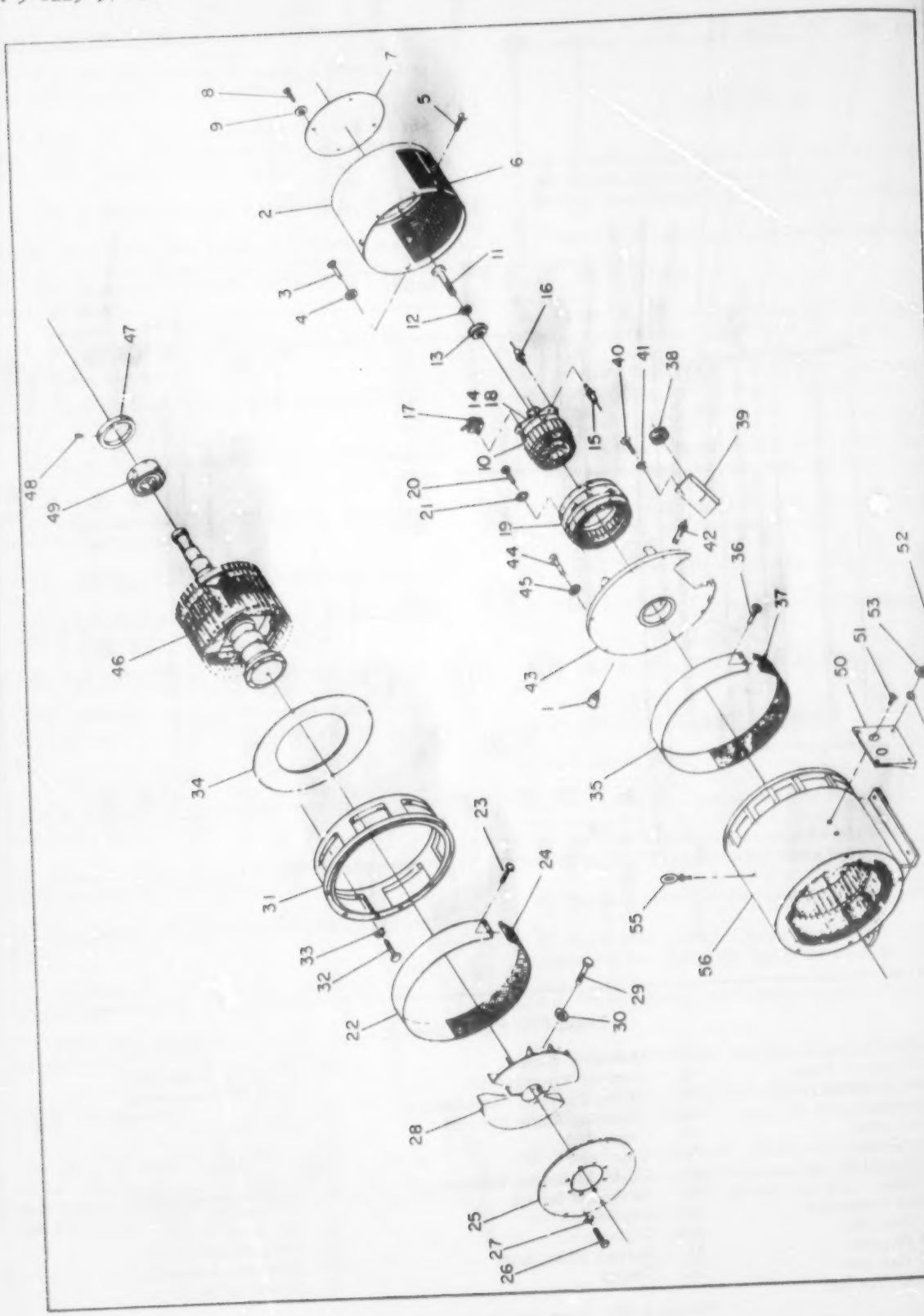


Figure 2-43. Alternating Current Generator

Legend To Figure 2-43

1. Grease Cup
2. Endbell Cover
3. Machine Screw
4. Lock Washer
5. Machine Screw
6. Captive Nut
7. End Cover Plate
8. Machine Screw
9. Lock Washer
10. Exciter Armature
11. Hex. Hd Cap Screw
12. Lock Washer
13. Retaining Washer
14. Rectifier Assembly
15. Diode Std. Semiconductor Device
16. Diode Std. Semiconductor Device
17. Surge Protector
18. Rectifier Hub and Plate
19. Exciter Field Assembly
20. Hex. Hd Cap Screw
21. Lock Washer
22. Adaptor Cover
23. Machine Screw
24. Captive Nut
25. Drive Plate
26. Hex. Hd Cap Screw
27. Lock Washer
28. Blower Fan
29. Hex. Hd Cap Screw
30. Lock Washer
31. Adaptor
32. Hex. Hd Cap Screw
33. Lock Washer
34. Baffle
35. Frame Band
36. Machine Screw
37. Captive Nut
38. Grommet
39. Outlet Cover
40. Machine Screw
41. Lock Washer
42. Grease Drain Assembly
43. Endbell
44. Hex. Hd Cap Screw
45. Lock Washer
46. Rotor Assembly
47. Bearing Seal
48. Setscrew
49. Bearing
50. Lead Elec. Block
51. Machine Screw
52. Hex. Hd Cap Screw
53. Flat Washer
54. Lock Washer
55. Eye Bolt
56. Frame and Stator Assembly

2-199. REASSEMBLY. Reassembly is the reverse of disassembly. Note the following:

a. Install electrical leads as indicated by tags prepared at disassembly.

b. Press new bearing on shaft against shoulder, being careful to keep dirt and other foreign matter out of the bearing.

NOTE

No further testing of ac generator required.

2-200. DIESEL ENGINE ASSEMBLY.

2-201. SPECIAL TOOLS. No special tools are required to overhaul the diesel engine assembly.

2-202. DISASSEMBLY. Disassemble the diesel engine assembly by following the sequence of index numbers in figure 2-44. Refer to paragraph 2-211 for overhaul of overspeed switch and paragraph 2-247 for overhaul of basic engine.

2-203. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

c. Steam clean diesel engine assembly after removal of electrical equipment.

d. Clean electrical parts with a soft bristle brush moistened with trichlorethylene, Military Specification MIL-T-7003.

WARNING

When using trichlorethylene, Military Specification MIL-T-7003, make sure that there is adequate ventilation, as fumes are toxic. Avoid prolonged exposure of bare skin to fumes.

2-204. INSPECTION. Check pipe and pipe fittings for signs of wear, cracks, distortion, and stripped threads. Inspect switch contacts for signs of pitting.

2-205. TESTING.

2-206. PRESSURE AND THERMAL SWITCH AND RELAY TESTS.

a. Connect an ohmmeter to the contacts of the coolant temperature thermal switch S6 (31 figure 2-44). Place the thermometer and switch sensing element in heat oil pot. Check ohmmeter to determine whether contacts of switch close at 220°F (102°C).

b. Using a similar test setup, check whether the contacts of the lubricating oil heater switch S2 open at 110°F (43°C).

c. Using an ohmmeter and a regulated source of air pressure, check fuel pressure switch S17 (2) to determine whether it closes at 120 psi.

d. Using a similar test setup, adjust air to 10 psi and check ohmmeter to see whether contacts of S2 and S8 (40) open.

2-207. OVERSPEED SWITCH TEST.

a. Connect an ohmmeter to the S1 contacts of the switch and a second ohmmeter to the S7 contacts of the switch.

b. Connect the drive shaft of the switch assembly to a variable speed motor with a range to 2500 rpm and a means of monitoring motor speed.

c. Operate motor and check to see whether S1 closes at 600 to 800 rpm.

d. Increase speed of motor to 2100 rpm. Check ohmmeter to see whether S7 closes.

e. Shutdown motor and adjust switch settings as described in paragraph 2-208.

NOTE

Refer to paragraph 2-211 for overhaul of overspeed switch.

2-208. REPAIR OR REPLACEMENT.

a. Replace faulty of defective pressure and thermal switches.

Table 2-2. Electrical Tests of Generator Components

Component Under test	Test Procedure	Value Required
Generator Stator	Test Resistance	Avg. 0.02056 ohms at 208 volt connection
Generator Rotor	Test Resistance	Avg. 4.036 ohms
Exciter Stator	Test Resistance	Avg. 5.5 ohms
Exciter Field	Test Resistance	4.4 ohms ±10%
Exciter Field	Test Field Current (Minimum no-load)	0.7 amp
	Test Field Current (Maximum full load)	2.7 amp
Rectifier	Isolate each diode. Use Multimeter with wide range ohmmeter. Connect ohmmeter leads across diode in one direction. Note meter reading. Reverse leads and note meter reading.	The meter should indicate a low resistance (under 1000 ohms) in one direction and a high resistance (1 megohm to infinity) in the other direction. NOTE If meter indicates a low resistance in both directions, the diode is shorted. A high resistance in both directions indicates an open diode.
Surge Protector	Disconnect one lead of surge protector and connect ohmmeter leads across surge protector. Note meter reading. Reverse leads and note meter reading.	The meter should indicate a high resistance in both directions. A low resistance indicates a shorted surge protector.

b. Replace pipe fittings that have stripped threads, cracks, or are otherwise defective.

c. Adjust overspeed switch as follows:

1. Both switches in the assembly may be individually adjusted. The dust cover screw labeled "1" covers the low speed adjustment. The screw labeled "2" covers the high speed adjustment.

2. Remove the appropriate dust cover screw for the adjustment required.

3. Insert a 1/16 inch Allen wrench into adjusting screw.

4. Turn clockwise to increase trip rpm. Turn counterclockwise to decrease trip rpm.

5. Repeat speed tests made in paragraph 2-207.

d. If switch assembly cannot be adjusted properly, perform adjustment procedure given in paragraph 2-219.

2-209. LUBRICATION. Lubricate speed adjusting switch as described in paragraph 2-218.

2-210. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-211. OVERSPEED SWITCH ASSEMBLY.

2-212. SPECIAL TOOLS. No special tools are required to overhaul the overspeed switch.

2-213. DISASSEMBLY. Disassemble overspeed switch by following the sequence of index numbers in figure 2-45. Note the following.

a. Before removing switches, note their position in the assembly. The switches should be positioned so that there is approximately 1/64 inch clearance between switch button and the lifters.

b. Before removing the governor cap note the position of cap and body marking. Use Tru-arc pliers to remove retaining ring.

c. Use a 5/16 inch open end wrench to hold adjusting stud and spring housing and use a 3/8 inch open end wrench to loosen nut. After this nut is removed, the adjusting spring and associated parts may be removed.

Table 2-3. Generator Rebuild Information

a. Generator Classification and Rating	
Full Load Amperes	347/173.5
Rating KVA	125
Power Factor	100 KW
RPM	1800
Voltage	120/208 - 240/416
No. of Wires	12
Excitation	Brushless
Excitation Amperes	2,7
Excitation Volts	
Duty Classification	Continuous
Degree of Enclosure	Dripproof - Protected
Cooling	Fan Action of Rotor
Drive	Engine
b. Generator Stator	
Number of Slots	48
Number of Coils	4 per group - 12 groups
	5 turns par. 5 # 15 HPT per coil
	1 # 16 HPT
Coil Span	1 - 9
Hookup Connection	2 par. 12 wire
Baking	Class F Varnish
Fungus Treat	Frost's LU-739 MIL-U-173A
Resistance Average	0.02056 at 208 volt connection
c. Generator Rotor	
Number of Coils	4
Turns Per Coil	300 turns # 11 RD.D.D.
Connection	4 series
Resistance Average	4.036 OHMS
Baking	Vacuum Impregnated
d. Exciter Armature	
No. of Poles	8
Phases	3
No. of Turns	15 turns # 17 HPT Pitch 1 - 4
	4 coils per phase
Hookup	Series star
e. Exciter Stator	
Number of Coils	8
Hookup	8 Series
Resistance Average	5.5 OHMS
Maximum Allowable Circulating Current	17.0 Amperes
	NOTE
	The allowable circulating current shall not exceed 10% of the rated line current per leg.
Number of Turns	180 turns par. # 19 HPT

d. Do not allow dirt to come in contact with any of the removed parts.

2-214. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

c. Clean contacts to switch with a soft bristle brush moistened with trichlorethylene, Military Specification MIL-T-7003.

WARNING

When using trichlorethylene, Military Specification MIL-T-7003, make sure that there is adequate ventilation, as fumes are toxic. Avoid prolonged exposure of bare skin to fumes.

d. Wash bearings, sleeves, rings, and sleeve bushings in cleaning solvent, Federal Specification P-S-661.

e. Blow residual grease out of bearing, using dry compressed air.

f. Repeat step d., agitating components rapidly to remove all grease.

g. Dry again with compressed air.

2-215. INSPECTION.

a. Check bearings and related parts for wear.

b. Inspect governor components for cracks and damage due to overspeeding.

c. Check switch contacts for pitting.

d. Inspect electrical lead assembly for faulty insulation.

e. Check springs for proper tension.

2-216. TESTING. Test continuity of switch contacts

2-217. REPAIR OR REPLACEMENT. Replace all worn, damaged, or otherwise defective parts. If switch contacts are pitted, burnish carefully to restore continuity.

2-218. LUBRICATION. Fill grease reservoir between bearings approximately 3/4 full with Texaco Unitemp grease or equivalent.

2-219. REASSEMBLY. Reassembly is essentially the reverse of disassembly. Note the following adjustment procedure.

a. If, after reassembly, the low speed switch trips at a far higher point than normal, lower cap position slightly. (Refer to paragraph 2-207 for test procedure). If the high speed switch trips at a very low speed, raise cap slightly.

b. If cap adjustment fails to properly adjust switch trip points, turn low speed adjusting screw counterclockwise for a minimum speed adjustment (approximately 1/8 inch from the top of the dust cover).

Legend To Figure 2-44

1. Overspeed Switch
2. Pressure Switch
3. Elbow
4. Clamp
5. Screw, Lockwasher, Nut
6. Bracket
7. Nipple
8. Elbow
9. Stl Close Nipple
10. Clamp
11. Screw, Lockwasher, Nut
12. Bracket
13. Clamp
14. Bracket
15. Screw, Lockwasher, Nut
16. Clamp
17. Clamp
18. Screw, Lockwasher, Nut
19. Bracket
20. Clamp
21. Screw, Lockwasher, Nut
22. Bracket
23. Hex. Hd Cap Screw
24. Bond Strap
25. Clamp
26. Elbow
27. Bushing
28. Plug
29. Filter Assembly
30. Lock Washer
31. Thermal Switch
32. Thermal Switch
33. Temperature Sending Unit
34. Magnetic Pick Up
35. Lock Nut
36. Body
37. Screw, Lockwasher
38. Grounding Strap
39. Lube Oil Pressure Sender
40. Pressure Switch
41. Tee
42. Pipe Nipple
43. Case and Cover Relay
44. Flat Washer
45. Thermostat
46. Tube Assembly
47. Tube Assembly
48. Screw, Lockwasher, Nut
49. Actuator
50. Screw, Lockwasher, Flatwash Nut
51. Actuator Bracket
52. Actuator Bracket Support
53. Oil Pan
54. Engine

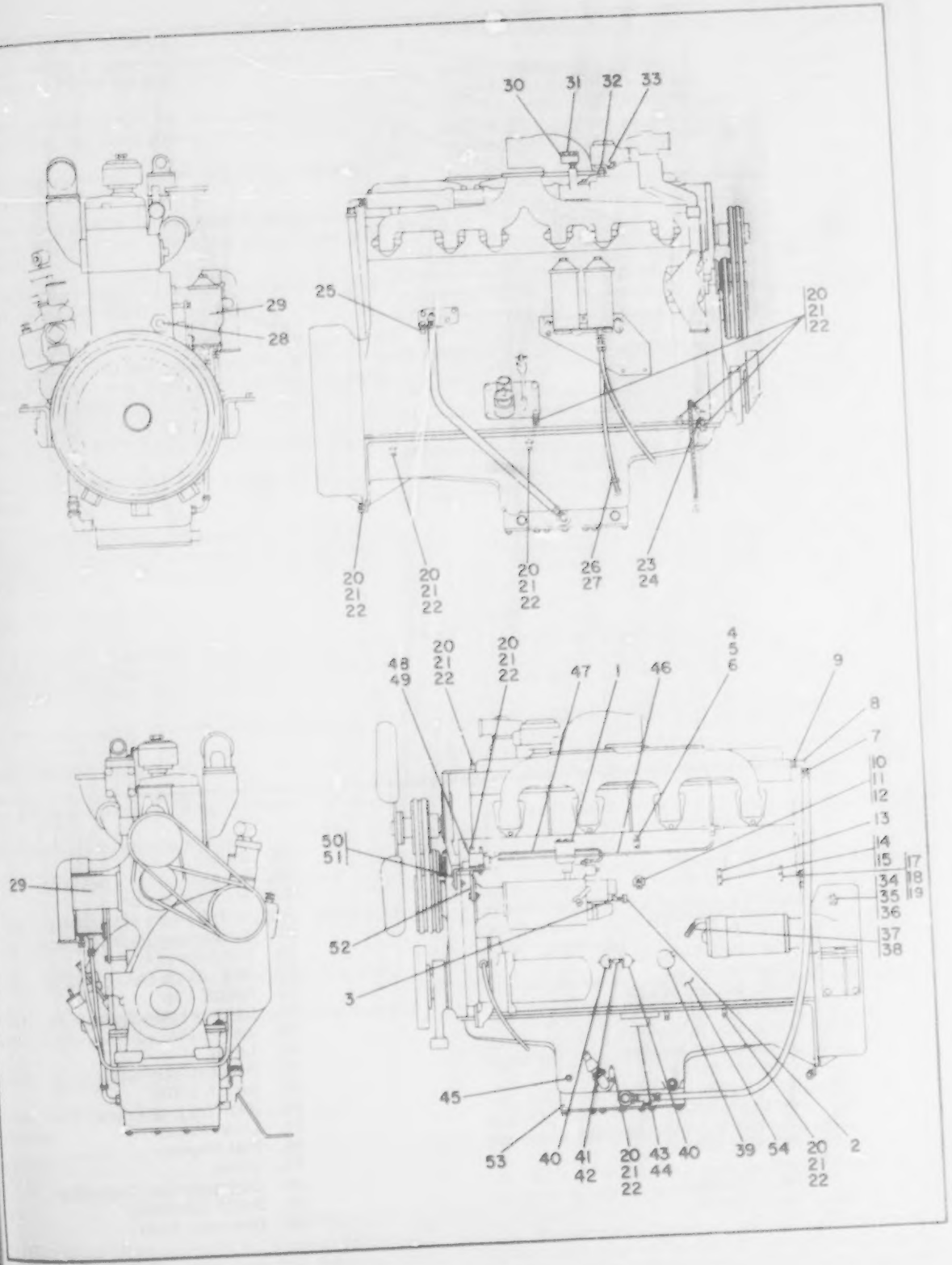
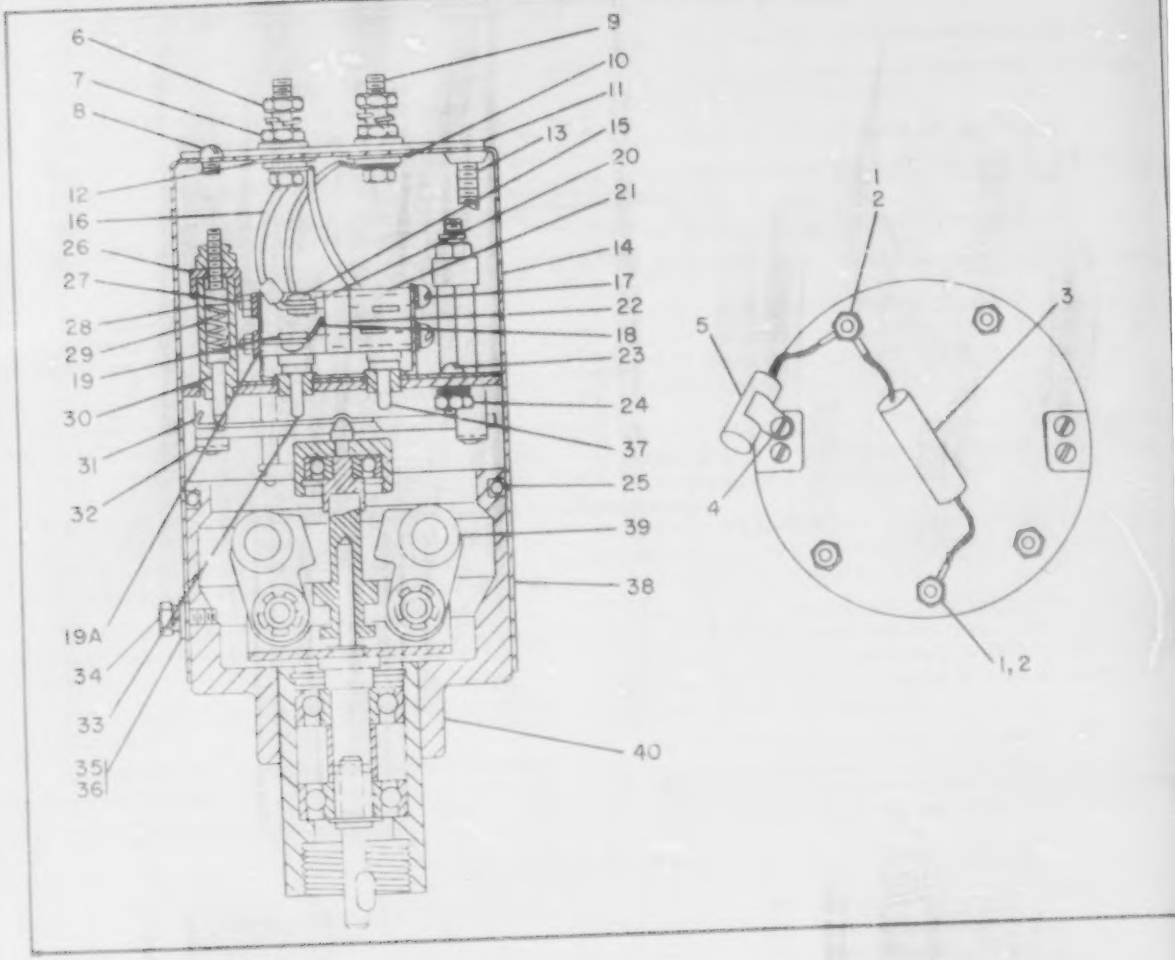


Figure 2-44. Engine Assembly



1. Nut
2. Terminal Lug
3. Fixed Capacitor
4. Screw
5. Fixed Capacitor
6. Hex. Plain Nut
7. Hex. Self-Locking Nut
8. Machine Screw
9. Hex. Hd Cap Screw
10. Bushing
11. Nonmetallic Washer
12. Nonmetallic Washer
13. Machine Screw
14. Dust Cover
15. Machine Screw
16. Electrical Lead Assembly
17. Machine Screw
18. Lug
19. Lock Washer
19A. Lock Washer
20. Switch
21. Switch
22. Spacer
23. Machine Screw
24. Self-Locking Hex. Nut
25. Preformed Packing
26. Nut Assembly
27. Hex. Plain Nut
28. Spring Cap
29. Compression Spring
30. Spring Pin
31. Lever
32. Bracket Assembly
33. Switch Lifter
34. Hex. Hd Cap Screw
35. Lock Washer
36. Flat Washer
37. Lifter
38. Governor Cap Assembly
39. Rotor Assembly
40. Governor Body

Figure 2-45. Overspeed Switch Assembly

c. Turn high speed adjusting screw clockwise for aximum speed adjustment (approximately 5/16 ch from the top of the dust cover).

d. With partial tension on cap holding screws, rn governor cap to maximum extended position.

e. Operate governor at 200 rpm above trip point low speed switch.

f. Turn cap slowly in clockwise direction until w speed switch trips. Mark cap position and stop vernor.

g. Turn cap another 1/16 inch clockwise. Tighten lding screws securely.

h. Repeat test procedure given in paragraph 2-207. he trip point of the low speed switch will have to be creased and the trip point of the high speed switch ll have to be decreased.

220. LUBRICATING OIL FILTER ASSEMBLY.

221. SPECIAL TOOLS. No special tools quired.

222. DISASSEMBLY. Disassemble the oil filter sembly by following the sequence of index numrs in figure 2-46. Discard gaskets (6 and 11).

223. CLEANING.

a. Wash painted surfaces with a mild soap and ter solution. Rinse with clean water. Wipe the rface with a clean, damp, lint free cloth.

b. Dry with clean, filtered, compressed air.

224. INSPECTION.

a. Check threaded parts for stripped threads.

b. Check for cracks and leaks.

225. TESTING. No testing required.

226. REPAIR OR REPLACEMENT. Replace all fective parts. Replace gaskets.

227. LUBRICATION. No lubrication required.

228. REASSEMBLY. Reassemble in the reverse der of disassembly.

229. MAGNETIC PICKUP.

230. SPECIAL TOOLS. No special tools uired.

WARNING

hen using Chlorothene N.U. Federal Specification O-T-620C, make sure that there is dequate ventilation and that solvent-proof othing is worn.

2-231. DISASSEMBLY. No disassembly required.

2-232. CLEANING. Clean external portion of magnetic pickup with soft bristle brush moistened with Chlorothene N.U. Federal Specification O-T-620C. Air dry with filtered, low pressure, compressed air.

2-233. INSPECTION. Inspect magnetic pickup assembly in the following manner:

a. Examine tip of pickup for evidence of wear, i.e. improper contact with engine flywheel teeth.

b. Inspect body for damaged and cross threads.

c. Inspect insulation at body head and connect leads for evidence of broken and abraded wires.

d. Inspect connector at end of leads for poor contact and broken insulation.

2-234. TESTING. Test resistance value of magnetic pickup assembly with standard volt ohmmeter. Nominal resistance at 70°F should be approximately 120 ohms.

2-235. REPAIR OR REPLACEMENT. Replace complete magnetic pickup assembly if inspection revealed any defects.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.

2-236. LUBRICATION. No lubrication required.

2-237. REASSEMBLY. Reassemble the magnetic pickup into flywheel housing as follows:

a. Chase threaded hole in flywheel housing with a 0.625 inch (5/8) inch - 18 UNF -2B tap.

b. Rotate the engine flywheel at least 1/4 turn to make certain that no metal chips produced by the previous drilling and tapping operations are on the gear teeth. A ring gear tooth must be centered on the tapped hole.

c. Screw the magnetic pickup into the tapped hole.

d. Check the air gap between the tip of the pickup and the top of a ring gear tooth with a feeler gauge and adjust the air gap to 0.020 - 0.040 inch.

e. Lock the magnetic pickup in place with the securing nut. Where it is not possible to set the air gap with a feeler gauge, proceed as follows:

f. Rotate the flywheel until the top of a tooth is centered on the tapped hole.

g. Measure the distance from the top of the tooth to the outer edge of the tapped hole and place a pencil eye mark on the pickup threads at a similar distance measured from the tip of the pickup.

h. Carefully screw the magnetic pickup into the apped hole until the pencil eye mark is even with e outer edge of the tapped hole and the tip of the ckup just touches the ring gear tooth.

NOTE

If the magnetic pickup seems to bottom before the pencil eye mark is even with the outer edge of the tapped hole, there is either a metal chip in, or a burr on the tapped hole threads, and the threads must be cleaned up.

i. Once it is certain that the magnetic pickup has ottomed on the ring gear tooth, back the pickup off ne half turn counterclockwise and secure it in place ith the securing nut.

-238. ACTUATOR ASSEMBLY.

-239. SPE CIAL TOOLS. No special tools required.

-240. DISASSEMBLY. Disassemble actuator sembly in accordance with figure 2-47 and 2-47A.

NOTE

This task must be accomplished in a very clean dust free work area. Dirt is the worst enemy of any precision governing mechanism.

a. Remove the metering valve from the actuator over plate. (Remove four 1/4-20 fillister head screws).

b. Clamp the valve body lightly in a vise and loosen he top nut several times with a 7/8" box end wrench. Loosen the bottom nut several times with an 11/16" ox end wrench.

c. Remove the valve assembly from the vise. Completely remove the top nut assembly.

NOTE

Do not allow internal parts to drop out and become damaged during removal.

d. Carefully remove the bottom nut. Remove the nut, pring, and shim discs below the spring in the recess f the nut. Carefully slide the piston out of the valve ody.

e. Remove cover from housing (4).

f. Press shaft (14) from armature and housing sembly after first removing the valve link sembly (11).

g. Press bearings (15) from housing only if replacement is necessary.

-241. CLEANING. Clean internal and basic housing s described below:

a. Flush the hydraulic metering valve assembly (1) ith chlorothene N.U. Federal Specification O-T-620C.

NOTE

When using chlorothene N.U., Federal Specification O-T-620C, make sure that there is adequate ventilation and that solvent proof clothing is worn.

b. Rinse the remaining internal parts of the metering valve assembly with chlorothene N.U., or clean diesel fuel. Wipe all parts with a clean lint free cloth.

c. Pull a small piece of clean cloth soaked in diesel fuel through the hole in the valve body.

d. Air dry all components with filtered low pressure (dry) air.

2-242. INSPECTION. Inspect actuator assembly in the following manner:

a. Inspect metering valve for evidence of wear and physical obstruction, binding and excessive sideplay during vertical travel.

b. Inspect all threaded fuel connection parts for cracked and damaged threads.

c. Inspect metering valve cover gasket for cracks.

d. Examine shaft (14) for evidence of worn end serations.

e. Inspect armature assembly (16) and remaining mechanical components for evidence of excessive wear.

f. Carefully examine bearings (15) for freedom of motion.

g. Inspect spring thrust armature (10) for signs of fatigue and coil breakage.

h. Inspect coil (14) for insulation breakage and security of lead connection.

i. Inspect receptacle (19) pin connections and external threads.

j. Inspect all internal wiring for evidence of abrasion and faulty connections.

2-243. TESTING. Test coil windings with an ohmmeter. Points A to B of connector should read 9 ohms ± 10%; points C to D should read 9 ohms ± 10% points E to F should read 15.5 ohms ± 10%. Refer to Section III for operational test procedures.

2-244. REPAIR OR REPLACEMENT. Replace any defective component noted during inspection.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.

2-245. LUBRICATION. Lubricate only the parts of valve assembly with diesel fuel.

2-246. REASSEMBLY. Reassemble the actuator assembly in reverse order of disassembly. See figure 2-47 and 2-47A. Note the following:

a. Dip piston and metering valve body in diesel fuel. Insert piston into valve body with the "V" slots toward the top of the valve body. (This "In" port identifies the top end of the body).

b. Dip all other parts in clean diesel fuel just prior to assembly. Put the shim discs in the bottom of the recess in the lower nut. Put one end of the spring in the recess, on top of the shim discs. Insert this assembly into the lower end of the valve body making sure the top end of the spring enters the recess on the bottom of the piston. Tighten the nut to 80 - 90 inch pounds.

2-247. DIESEL ENGINE.

2-248. SPECIAL TOOLS. No special tools are required to overhaul the diesel engine.

2-249. DISASSEMBLY. Disassemble the diesel engine by following the sequence of index numbers in figure 2-48. Be sure to observe the following precautions during disassembly of the diesel engine.

a. Grasp each fuel injector assembly housing and lift from cylinder.

b. Place all fuel injector assemblies in a rack and identify each unit with the number of the cylinder from which it was removed.

c. To remove connecting rod assembly, remove nut, lockplate, and bolts from connecting rod assembly. Use a nylon mallet to remove bolt. Remove lower half of sleeve bearing.

NOTE

Tag each sleeve bearing with the cylinder number as it is removed. All sleeve bearings are matched and not interchangeable.

d. Remove screw, lockplate journal, and lower half of main bearing.

NOTE

Tag each main bearing with an appropriate number as it is removed from the crankshaft all main bearings are matched and are not interchangeable.

e. Using a wooden stick, push the connecting rod assembly (30) figure 2-48) up through the cylinder liner.

f. Remove crankshaft assembly (31).

g. Replace components of connecting rod assembly removed in step c.

NOTE

Presence of a new part in the applicable kit eliminates the necessity of cleaning, inspecting, or reworking the used part. Residue from kits and removed parts in this category shall be administratively condemned. The instructions which follow cover removed parts not supplied in kits and kitted parts (if any) which require cleaning, inspecting, or testing prior to installation.

2-250. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

2-251. INSPECTION. Inspect tubing, clamps, connector, and manifold for cracks, corrosion, and distortion. Inspect fuel drain components for leaks.

2-252. TESTING. No testing is required.

2-253. REPAIR OR REPLACEMENT. Replace all defective, worn, or damaged parts.

2-254. LUBRICATION. No lubrication is required.

2-255. REASSEMBLY. Reassemble in the reverse of disassembly. Note the following precautions:

CAUTION

Torque values for all major subassemblies and their attachment hardware are contained in the particular descriptive text, or provided in tables 2-4, 2-5 and 2-6.

a. Install crankshaft and then install upper half of main bearings. Be sure that main bearing bushings are installed so that wide portion is toward flywheel end of cylinder block.

b. Install lower half of main bushings and tighten cap screws slowly to set main bearing caps into position.

c. Tighten cap screws to 150 foot-pounds torque and advance cap screws 30 degrees.

d. Loosen cap screws completely and retighten capscrews to 140 foot-pounds.

e. Scribe each cap in line with one corner of each capscrew and advance capscrew 30 degrees.

f. Attach dial indicator gage to cylinder block with contact point of gage resting on crankshaft flange end face.

g. With pry bar, pry crankshaft toward front of engine.

h. Set gage to 0.

i. Pry crankshaft toward back of engine.

j. Total gage reading should be 0.007 - 0.013 inch. If reading is less than 0.007 or more than 0.013 inch, loosen bearing capscrews slightly, shift crankshaft first toward front and then toward back of cylinder block. Retighten capscrews. (Refer to steps c through e).

k. Rotate crankshaft so that any two crank throws are at bottom center position.

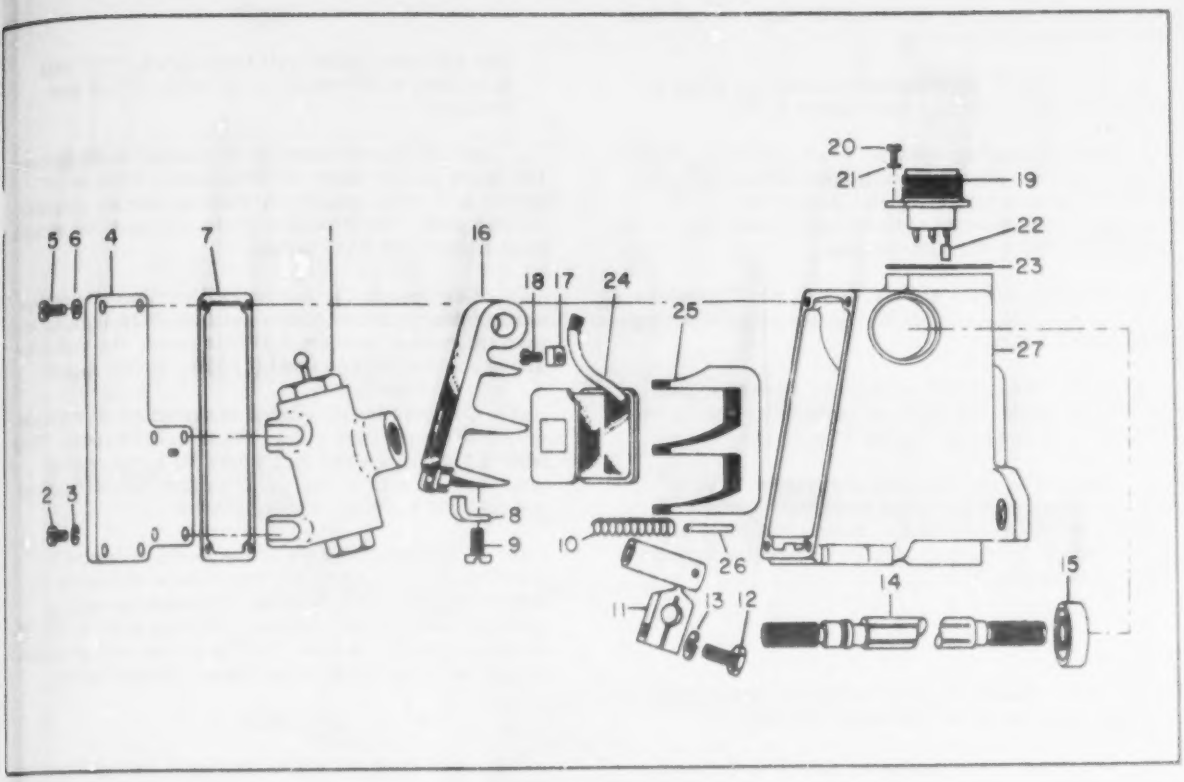
l. Remove connecting rod cap from bolts.

m. Insert connecting rod and piston assembly into cylinder. Position numbered side of rod toward camshaft side of block.

n. Grasp piston and rod by rod bolts and pull down to rod journal. Install rod cap over bolts so that numbered side of cap is matched with numbered side of rod.

o. Tighten nuts slowly to ensure even seating of rod cap. Torque nuts to 140 foot-pounds.

p. Loosen nuts completely and retighten nuts alternately to 50 - 55 foot-pounds in 5 foot-pound increments.



1. Metering Valve Assembly
2. Screw
3. Lock Washer
4. Cover
5. Screw
6. Lock Washer
7. Gasket
8. Armature Stop Bracket
9. Screw
10. Armature Thrust Spring
11. Valve Link Assembly
12. Screw
13. Lock Washer
14. Shaft
15. Ball Bearing
16. Armature Assembly
17. Coil Cable Clamp
18. Screw
19. Receptacle
20. Screw
21. Lock Washer
22. Insulation Tubing
23. Coil and Housing Assembly
24. Coil Assembly
25. Stator Assembly
26. Armature Stop Pin
27. Housing

Figure 2-47. Actuator Assembly

q. Tighten each nut additional 60 degrees and bend lock plates to secure nuts.

r. After installing camshaft assembly, index 0 mark on helical gears. (See figure 2-49).

s. After installing cylinder head assembly, tighten each capscrew slightly in sequence shown in figure 2-50. Continue tightening in rotation and in 100 foot-pound increments until all capscrews have been torqued to 460 - 480 foot-pounds.

t. Time the engine as follows: Timing cylinders 1, 3, and 5 will accomplish complete engine timing. (See figure 2-51).

u. Install timing tool in injector sleeve; engine short rod in injector pushrod socket and secure tool in place with long rod resting atop piston.

v. Bar engine in direction of rotation to TDC (highest point of piston rise when both intake and exhaust valves are closed). Install indicator above piston within 0.010 inch of fully compressed position. Set indicator dial at 0.

NOTE

Two dial indicators used in timing engine must have total travel of at least 0.250 inch.

w. Continue to bar engine in direction of rotation until rod reaches 90° mark on left side of tool.

x. Using same method described in step indicator above push rod to within 0.010 inch of its fully compressed position. Set indicator dial at 0.

y. Bar engine in direction opposite rotation to approximately 45° BTDC.

NOTE

The rod over piston will travel up to TDC and then down to 45° mark on left side of tool rod retainer.

z. Bar engine in direction of rotation until indicator above piston reads -0.2032 inch. This is 19° BTDC or 0.2032 inch lower than top center position. At this point, the indicator above the pushrod should read 0.0275 - 0.0315 inches.

aa. Continue to bar engine in direction of rotation until indicator above piston reads 0.0816 inch lower than top center position. At this point, the indicator above pushrod should read 0.0130 - 0.065 inches.

ab. Continue to bar engine in direction of rotation until indicator above piston reads 0.0143 inch. This is 5° BTDC or 0.0143 inch lower than top center position. At this point, the indicator above pushrod should read 0.0020 - 0.0050 inches.

ac. If downward travel of the pushrod (from 90° ATDC position) is greater than limits indicated in table, engine timing is slow. Correct by adding gaskets between cam follower housing and block. If downward travel is less, timing is fast and gaskets should be removed to bring timing within limits.

NOTE

An extra thick (0.026/0.036 inch) gasket should be used where needed instead of several thin gaskets.

ad. Secure rocker level housing assembly to cylinder block assembly.

ae. Torque screws to between 55 - 75 foot-pound in sequence shown in figure 2-52.

Legend For Figure 2-48

1. Thermostat Housing Assembly
1A. Crankcase Breather Assembly
2. Air Intake Manifold Assembly
3. Exhaust Manifold Assembly
4. Water Manifold Assembly
5. Water Pump and Fan Hub Assembly
6. Gear Case Cover Assembly
7. Lub Oil Filter Assembly
8. Lub Oil Pump
9. Fuel Pump Assembly
10. Fuel Pump Drive Assembly
11. Fuel Filter Assembly
12. Starter, Engine Electrical
13. Ferrule
14. Hex. Plain Nut
15. Manifold
16. Drain Manifold Connector
17. Loop Clamp
18. Hex. Hd Cap Screw
19. Fuel Drain Manifold
20. Fuel Drain Connection Assembly
21. Fuel Inlet Connection Assembly
22. Lub Oil Cooler Assembly
23. Rocker Lever and Cover Housing Asse
24. Fuel Injector Assembly
25. Flywheel and Cover Assembly
26. Cylinder Head Assembly
27. Oil Pan and Gage Assembly
28. Cam Follower Housing Assembly
29. Camshaft Assembly
30. Connecting Rod Assembly
31. Crankshaft Assembly
32. Cylinder Block Assembly

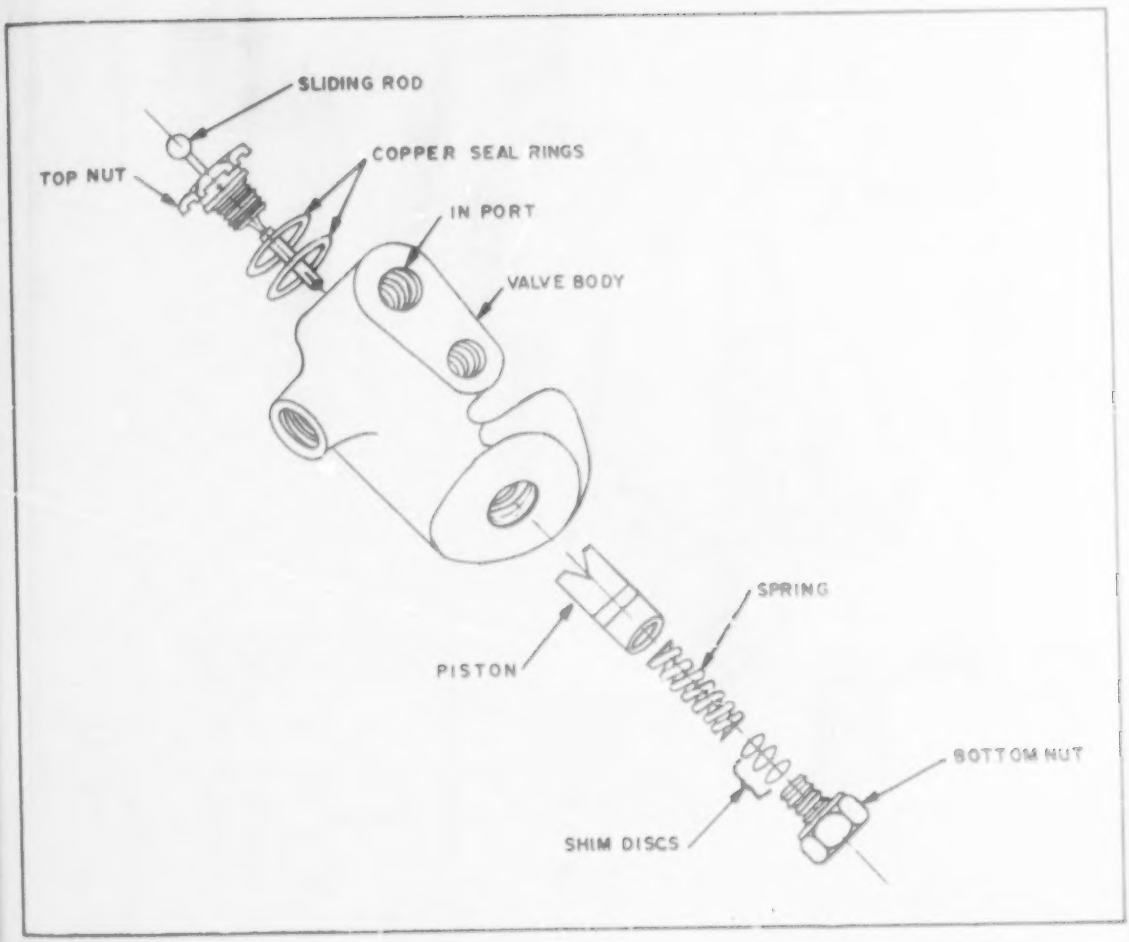


Figure 2-47A. Actuator Metering Valve Assembly

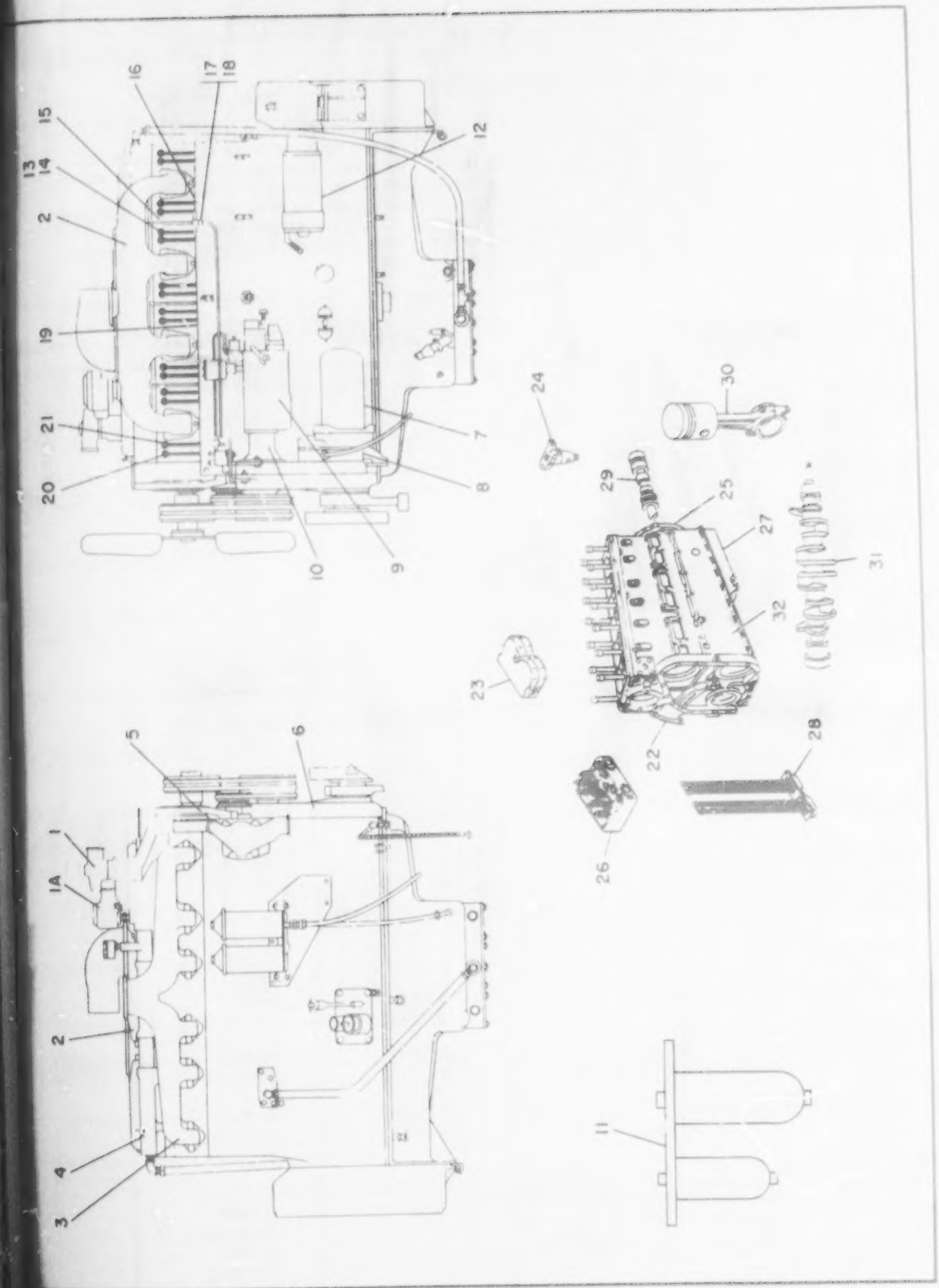


Figure 2-48. Diesel Engine

Table 2-4. Component Specifications and Wear Limits

NOTE

Worn limits as stated in this technical order indicates that the part may be reused if it is at the worn limit. Discard only if it exceeds the worn limit. Of course, the reuse of any part is partially the responsibility of the person making the inspection, as it could well be damaged in an area not listed as a worn limit, thus making it unfit for further use. Limits are given in U.S. and Metric measurements. All Metric units are enclosed in brackets ().

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Cylinder Block Installed Camshaft Bushing Inside Diameter	1.9990 (50.7746)	2.0005 (50.8127)	2.0015 (50.8381)
Camshaft Bushing Bore in Block	2.1285 (54.0639)	2.1295 (54.0893)	2.1305 (54.1147)
Cylinder Liner Counterbore Inside Diameter	6.1240 (155.5496)	6.1260 (155.6004)	
Muffler and Piping Exhaust Back Pressure In. Hg. Naturally Aspriated		1.5 (38.1000)	
Cranking Motors (Electric)	Refer to paragraph 2-425.		
Engine Assembly Crankshaft End Clearance	0.0070 (0.1778)	0.0170 (0.4318)	0.0220 (0.5588)
Cylinder Liner Protrusion	0.0040 (0.1016)	0.0060 (0.3810)	
Cylinder Liner Out-of-Round Top/in. (25.4000)		0.0030 (0.0762)	
Lower Area		0.0020 (0.0508)	
Connecting Rod Side Clearance	0.0060 (0.1524)	0.0110 (0.2794)	
Gear Backlash - Gear to Gear Crankshaft, Camshaft, Fuel Pump Drive, Idler, and Lubricating Oil Pump Gears	0.0060 (0.1524)	0.0090 (0.2286)	0.0200 (0.5080)
Camshaft End Clearance	0.0010 (0.0254)	0.0030 (0.0762)	
Injector and Valve Adjustment at 70° (21.1°C) Intake		0.0160 (0.4064)	
Exhaust		0.0290 (0.7366)	
Injector in. lb. (kg m)		48 (0.5520)	

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Adjustment at 140° (60°C)			
Intake		0.0140 (0.3556)	
Exhaust		0.0270 (0.9398)	
Injector in. lb. (kg m)		60 (0.6900)	
Connecting Rod Nuts ft. lb. (kg m)			
Injector Hold-Down Capscrew ft-lb (kg m)			
Standard	10 (1.3830)	12 (1.6596)	
Nylock Capscrews	12 (1.6596)	14 (1.9362)	
Counterbore Depth	0.4340 (11.0246)	0.4350 (11.0490)	0.4970 (12.6238)
Liner Protrusion	0.0040 (0.1016)	0.0060 (0.1524)	
Liner-to-Block Clearance			
Lower Bore	0.0020 (0.0508)	0.0080 (0.2032)	
Cylinder Block Lower Liner Bore	5.7490 (146.0246)	5.7510 (146.0754)	
Main Bearing Bore	4.7485 (120.6119)	4.7500 (120.6500)	4.7505 (120.6627)
Main Bearing Bore Alignment	(Check with ST-136)		
Main Bearing Capscrew Tightening Ft-lb (kg m)			
1. Tighten to	145 (20.0535)	155 (21.4365)	
2. Advance	300 (41.4900)	310 (42.8730)	
3. Loosen	All	All	
4. Tighten to	140 (19.3620)	145 (20.0535)	
5. Advance	30°	30°	
Cylinder Block Height From Main Bearing Bore Center Liner	19.0040 (482.7016)	19.0060 (482.7524)	18.9940 (482.4476)
From Top of Alignment Bar	16.6200 (422.3766)	16.6310 (422.4274)	16.6190 (422.1226)

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Cylinder Liner Counterbore	0.4340 (11.0236)	0.4350 (11.0490)	0.4970 (12.6238)
Cylinder Counterbore Shims			
Part No. 143938	0.0063 (0.1600)	0.0070 (0.1778)	
Part No. 143939	0.0072 (0.1828)	0.0088 (0.2235)	
Part No. 143946	0.0081 (0.2057)	0.0099 (0.2514)	
Part No. 143947	0.0180 (0.4572)	0.0220 (0.5588)	
Part No. 143948	0.0280 (0.7112)	0.0340 (0.8636)	
Part No. 143949	0.0560 (1.4224)	0.0680 (1.7272)	
Cylinder Liner			
Cylinder Liner Inside Diameter			
Cast Iron (5-1/8 in. bore)	5.1245	5.1260	5.1300
Chromate Plate (5-1/8 in. bore)	5.250	5.1280	5.1310
NOTE: Dimensions at 60/70°F (15.6/21.1°C); new liners with lubrite finish may be 0.0002/0.0006 in. (0.0050/0.0152 mm) smaller than indicated due to lubrite coating.			
Cylinder Liner Protrusion	0.0040 (0.1016)	0.0060 (0.1524)	
Idler Gear			
Bushing Inside Diameter			
Gear-Driven Generator	1.3745 (34.9123)	1.3755 (34.9377)	1.3770 (34.9758)
Fuel Pump Drive	1.3770 (34.9758)	1.3780 (35.0012)	1.3780 (35.0012)
Thrust Washer			0.0600 (1.5240)
Bearings			
Standard Size (Thickness)			
Main Bearing	0.1230 (4.3180)	0.1238 (4.3357)	0.1215 (4.2849)
Connecting Rods	0.0722 (3.1623)	0.0730 (3.1750)	0.0700 (3.1292)
Journal Clearance			
Main	0.0015 (0.0381)	0.0050 (0.1270)	0.0070 (0.1778)

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Connecting Rods	0.0015 (0.0381)	0.0045 (0.1143)	0.0070 (0.1778)
nkshaft Thrust Ring Thickness Part Nos.: 157280	0.2450 (6.2230)	0.2470 (6.2738)	
157281	0.2550 (6.4770)	0.2570 (6.5278)	
157282	0.2650 (6.7310)	0.2670 (6.7818)	
ankshaft End Clearance	0.0070 (0.1778)	0.0170 (0.4318)	0.0220 (0.5588)
bration Dampers Misalignment of Index Marks		0.0625 (1.5875)	
onnecting Rods Nut Tightening ft-lb (kg m)			
1. Tighten to	70 (9.6810)	75 (10.3725)	
2. Advance to		140 (19.3620)	
3. Loosen all	Completely		
4. Tighten to	25 (3.4575)	30 (4.1490)	
5. Advance to	50 (6.9150)	55 (7.6065)	
6. Advance	60°	60°	
Crankpin Bore Out-of-Round			0.0015 (0.0381)
Piston Pin Bushing	2.0010 (50.8254)	2.0015 (50.8381)	2.0025 (50.8635)
Connecting Rod Length Center to Center	11.9980 (304.7492)	12.0000 (304.8000)	
Connecting Rod Alignment Without Bushing			0.0080 (0.2032)
With Bushing			0.0040 (0.1016)

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Twist			0.0200 (0.5080)
Without Bushing			0.0100 (0.2540)
With Bushing			
Connecting Rod Bolt			
Minimum O.D.	0.5410 (13.7414)	0.5450 (13.8430)	0.5400 (13.7160)
Pilot O.D.	0.6245 (15.8523)	0.6250 (15.8750)	0.6242 (15.8546)
Bolt Hole Inside Diameter Pilot			
Rod	0.6243 (15.8572)	0.6248 (15.8699)	0.6249 (15.8724)
Cap	0.6243	0.6248	0.6249
Piston and Piston Rings			
Piston Pin Bore			
Aluminum	1.9987 (50.7669)	1.9991 (50.7771)	2.0000 (50.8000)
Cast Iron	1.9985 (50.7619)	1.9989 (50.7720)	1.9990 (50.7746)
Piston Pin Diameter	1.9988 (50.7695)	1.9990 (50.7746)	1.9978 (50.7541)
Camshaft			
Journal Diameter	1.9970 (50.7238)	1.9980 (50.7492)	1.9960 (50.6984)
Camshaft Support Bushing	1.3274 (34.8615)	1.3755 (34.9377)	1.3700 (34.7980)
Gear Case Cover			
Accessory Drive Bushing			
Part No. 132770	1.5650 (39.7510)	1.5630 (39.8526)	1.5710 (39.9034)
Part No. 132771	1.5550 (39.4070)	1.5590 (39.5986)	1.5610 (39.6496)
Part No. 132772	1.5450 (39.2440)	1.5490 (39.3446)	1.5510 (39.3954)
Cylinder Head			
Crosshead Guide Dimensions			
Solid O.D.	0.4330	0.4335	0.4310
Tubular I.D.	0.3750 (9.5250)	0.3760 (9.5504)	0.3780 (9.6012)
Height	5.4990	5.5000	5.4700
Injector Sleeve	1.5900 (39.8780)	1.5800 (40.1320)	
Top Inside Diameter	0.0400 (1.0160)	0.0550 (1.3970)	0.0650 (1.6510)
Injector Cup Protrusion			
Valve Seat and Insert			0.0020
Run-out			(0.0508)

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Valve Crossheads			
Crosshead Stem Dimensions			
Tubular I. D.	0.4340	0.4360	0.4400
Solid O. D.	0.3708 (9.4183)	0.3713 9.4310	0.3700 (9.3980)
Depth Valve Stem Pocket	0.1200 (3.0480)	0.1400 (3.5560)	
Valves, Guides and Springs			
Valve Stem Outside Diameter	0.4500 (11.4380)	0.4510 (11.4554)	0.4490 (11.4046)
Valve Guide Inside Diameter Four-Valve Head	0.4045	0.4052	0.4062
Valve Guide Protrusion Four-Valve Head	1.3150 (33.4010)	1.3250 (33.6550)	
Rocker Levers			
Bushing Inside Diameter	1.1245 (28.5623)	1.1275 (28.6385)	1.1286 (28.6639)
Shaft Outside Diameter	1.1230 (28.5242)	1.1240 (28.5496)	1.1220 (28.4988)
Push Tubes			
Ball End Radius	0.623 (15.8242)	0.625 (15.8750)	
Socket (Spherical I. D.)	0.505 (12.8270)	0.520 (13.2080)	
Cam Followers			
Shaft O. D.	0.7485 (19.0119)	0.7490 (19.0246)	0.7480 (18.9992)
Bushing I. D.	0.7495 (19.0373)	0.7505 (19.0627)	0.7515 (19.0881)
Cam Roller			
(Injector I. D.)	0.5030 (12.7762)	0.5040 (12.8016)	0.5050 (12.8270)
(Injector O. D.)	1.2490 (31.7246)	1.2510 (31.7754)	1.2470 (31.6738)
(Valve I. D.)	0.5005 (12.7127)	0.5015 (12.7381)	0.5030 (12.7762)
(Valve O. D.)	1.2490 (31.7246)	1.2500 (31.7500)	1.2470 (31.6738)
Pin O. D.	0.4995 (12.6873)	0.5000 (12.7000)	0.4970 (12.6238)
Lubricating Oil Pump			
Flange-Mounted Horizontal Filter Bushings	0.6165 (15.6591)	0.6175 (15.6545)	0.6185 (15.7099)
Water Pump			
Impeller to Shaft Press-Fit			0.001 (0.0254)
Impeller to Body Clearance	0.015 (0.3810)	0.035 (0.8890)	

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Fan Hub			
End Clearance	0.001 (0.0254)	0.007 (0.1778)	
Bearing to Shaft Press-Fit	0.001 (0.0254)		0.000 (0.000)
Thermostats			
Operating Range			
High	180° F (82.2° C)	195° F (90.6° C)	
Drive Units			
Fuel Pump Drive	1.3120	1.3150	1.3100
Bushing I.D.	0.005 (0.1270)	0.010 (0.2540)	
End Clearance			
Camshaft End Clearance	0.0010 (0.0254)	0.0030 (0.0762)	
(with thrust plate)	0.0080 (0.2032)	0.0010 (0.2540)	
(with out-board bearing support)			
Air Cleaner			
Restriction in. H_2O (kg/sq cm)		15 (0.0381)	
Oil Bath			
Fuel Inlet and Drain Connections ft-lb (kg m)	20	25	
Rocker Housing Capscrews ft-lb (kg-m)	55 (7.6085)	75 (10.3725)	
	Note: Refer to Fig. 2-52		
Lubricating Oil Pipe Cap ft-lb (kg m)	65	75	
Fuel Filter ft-lb (kg m)	20 (2.7660)	25 (3.4575)	
Second-Order Counterbalancer			
(4 Cylinder Engine)			
Housing to Block Capscrews	50 (6.9150)	55 (7.6065)	
Drive Assembly to Block Capscrews	30 (4.1490)	35 (4.8405)	
Flywheel Housing Capscrews		150 (20.7450)	
Flywheel Capscrews	190 (26.2770)	200 (27.6600)	
Crankshaft Flange Capscrew	180 (24.8940)	200 (27.6600)	
Note: If 139145 cast iron flange is used torque to	90 (12.4470)	100 (13.8300)	

Table 2-4. Component Specifications and Wear Limits (Continued)

Part or Location	5-1/8 in. bore		Worn Limit
	New Minimum	New Maximum	
Vibration Damper Capscrews ft-lb (kg m)		60 (8. 2980)	
Accessory Drive Pulley Nut ft-lb (kg m)	90 (12. 4470)	110 (15. 2130)	
Fan Hub Nut ft-lb (kg m)	400 (55. 3000)	500 (69. 1500)	
Exhaust Manifold Capscrews ft-lb (kg m)		25 (3. 4575)	
Oil Cooler and Filter Assembly	40 (5. 5320)	45 (6. 2235)	
Rocker Housing Cover Capscrews in. lb (kg m)	75 (0. 8625)	95 (1. 0925)	
Lubricating Oil Pressure Idle Speed P. S. I. (kg/sq cm)	5 (0. 3515)	20 (1. 4060)	
Rated Speed P. S. I. (kg/sq cm)	30 (2. 1090)	70 (4. 9210)	

Table 2-5. Major Components, Torque and Calibration Tightening

Part Name or Location	NH 5-1/8
CYLINDER BLOCK GROUP	
Main Bearing Stud Nuts or Capscrews - Ft/Lbs	
Step 1 Tighten	145/155
Step 2 Advance to	300/310
Step 3 Loosen	All
Step 4 Tighten	140/145
Step 5 Advance	30 deg.
Connecting Rod Nuts - Ft/Lbs	
Step 1 Tighten	70/75
Step 2 Tighten	140
Step 3 Loosen	All
Step 4 Tighten	25/30
Step 5 Tighten	50/55
Step 6 Advance	60 deg.
Vibration Damper Mounting Capscrews - Ft/Lbs	
Standard Capscrew	55/65
Conical Capscrew	70/80

Table 2-5. Major Components, Torque and Calibration Tightening (Continued)

Part Number or Location	NH 5-1/8
CYLINDER BLOCK GROUP (Cont)	
Vibration Damper Mounting Flange Capscrews - Ft/Lbs	180/200
Crankshaft Pulley Capscrews - Ft/Lbs	180/200
Crankshaft Pipe Plugs Ft/Lbs	5
Rear Crankshaft Cover - Ft/Lbs	25/28
CYLINDER HEAD GROUP	
Cylinder Head Capscrews - Ft/Lbs	
Step 1	25
In Increments of	100
To	200
Final Step	280/300
Tighten in Sequence	
Valve Crosshead Nuts - Ft/Lbs	25/30
with ST-669 Adapter	22/26

Table 2-5. Major Components, Torque and Calibration Tightening (Continued)

Part Name or Location	NH 5/18
CYLINDER HEAD GROUP (Cont)	
Fuel Fittings - Ft/Lbs	11/13
ROCKER LEVER, CAM FOLLOWER AND TAPPET GROUP	
Rocker Lever Hsg. Capscrews - Ft/Lbs	55/75
Valve, Injector Adjusting Screw Locknuts - Ft/Lbs	70/80
with ST-669 Adapter	60/70
Rocker Lever Shaft Plugs - Ft/Lbs	
Straight Plug	20/25
Taper Plug	20/30
Camfollower	30/35

Table 2-5. Major Components, Torque and Calibration Tightening (Continued)

Part Name or Location	NH 5-1/8
PT FUEL PUMP AND FILTERS GROUP	
Front Cover Capscrews - In/Lbs	90/95
Spring Pack Capscrews - In/Lbs	90/95
Fuel Filter (105204) Bolt - Ft/Lbs	20/25
1/2 In. Brass Filter Fittings - Ft/Lbs	30/40
Gear Pump Capscrews - Ft/Lbs	9/11
Throttle Shaft Plug - In/Lbs	40/55
Filter/Bracket Capscrews - Ft/Lbs	20/30
Paper Disc Filter Bolt - Ft/Lbs	25/35
Drain Plug - Ft/Lbs	5/10
INJECTOR AND CONNECTIONS GROUP	
Cups - Ft/Lbs	55
Orifice Plug - In/Lbs	8/10

Table 2-6. Standard Capscrew Markings and Torque Specifications

Usage		Much Used		Much Used		Used at Times		Used at Times	
Capscrew Head Markings Manufacturer's marks may vary. These are all SAE Grade 5 (3-line).									
Capscrew (Inches)	Body Size (Thread)	Torque		Torque		Torque		Torque	
		Ft-Lb	(kg m)	Ft-Lb	(kg m)	Ft-Lb	(kg m)	Ft-Lb	(kg m)
1/4	20	5	(0.6915)	8	(1.1064)	10	(1.3830)	12	(1.6596)
	28	6	(0.8298)	10	(1.3830)			14	(1.9362)
5/16	18	11	(1.5213)	17	(2.3511)	19	(2.6277)	24	(3.3192)
	24	13	(1.7979)	19	(2.6277)			27	(3.7341)
3/8	16	18	(2.4894)	31	(4.2873)	34	(4.7022)	44	(6.0852)
	24	20	(2.7660)	35	(4.8405)			49	(6.7767)
7/16	14	28	(3.8132)	49	(6.7767)	55	(7.6065)	70	(9.6810)
	20	30	(4.1490)	55	(7.6065)			78	(10.7874)
1/2	13	39	(5.3937)	75	(10.3725)	85	(11.7555)	105	(14.5215)
	20	41	(5.6703)	85	(11.7555)			120	(16.5960)
9/16	12	51	(7.0533)	110	(15.2130)	120	(16.5960)	155	(21.4365)
	18	55	(7.6065)	120	(16.5960)			170	(23.5110)

Table 2-6. Standard Capscrew Markings and Torque Specifications (Continued)

Capscrew (Inches)	Body Size (Thread)	Torque		Torque		Torque		Torque	
		Ft-Lb	(kg m)	Ft-Lb	(kg m)	Ft-Lb	(kg m)	Ft-Lb	(kg m)
5/8	11	83	(11.4789)	150	(20.7450)	167	(23.0961)	210	(29.0430)
	18	95	(13.1385)	170	(23.5110)			240	(33.1920)
3/4	10	105	(14.5215)	270	(37.3410)	280	(38.7240)	375	(51.8625)
	16	115	(15.9045)	295	(40.7985)			420	(58.0860)
7/8	9	160	(22.1280)	395	(54.6285)	440	(60.8520)	605	(83.6715)
	14	175	(24.2025)	435	(60.1605)			675	(93.3525)
1	8	235	(32.5005)	590	(81.5970)	660	(91.2780)	910	(125.8530)
	14	250	(34.5750)	660	(91.2780)			990	(136.9170)

1. Always use the torque values listed above when specific specifications are not available.

   Note: Do not use above values in place of those specified in the engine groups of this manual; special attention should be observed in case of SAE Grade 6, 7 and 8 capscrews.

2. The above is based on use of clean and dry threads

3. Reduce torque by 10% when engine oil is used as a lubricant.

4. Reduce torque by 20% if new plated capscrews are used.

CAUTION

Capscrews threaded into aluminum may require reductions in torque of 30% or more, unless inserts are used.

2-256. THERMOSTAT HOUSING ASSEMBLY AND CRANKCASE BREATHER ASSEMBLY.

2-257. SPECIAL TOOLS. No special tools are required to overhaul the thermostat housing and crankcase breather assemblies.

2-258. DISASSEMBLY. Disassemble thermostat housing and crankcase breather assemblies in accordance with figures 2-53 and 2-54.

NOTE

Presence of a new part in the applicable kit eliminates the necessity of cleaning, inspecting, or reworking the used part. Residue from kits and removed parts in this category shall be administratively condemned. The instructions which follow, cover removed parts not supplied in kits and kitted parts (if any) which require cleaning, inspecting, or testing prior to installation.

2-259. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

2-260. INSPECTION. Inspect all parts for wear, stripped threads, corrosion and other defects.

2-261. TESTING. Immerse thermostat in oil pot heated to 160° F. Thermostat should start to open. Thermostat should be fully opened at a temperature of 180° F.

2-262. REPAIR OR REPLACEMENT. Replace damaged, defective, and worn parts. Replace pipe plugs if corroded. Replace crankcase breather element (2) figure 2-54 at each overhaul interval.

2-263. LUBRICATION. No lubrication is required.

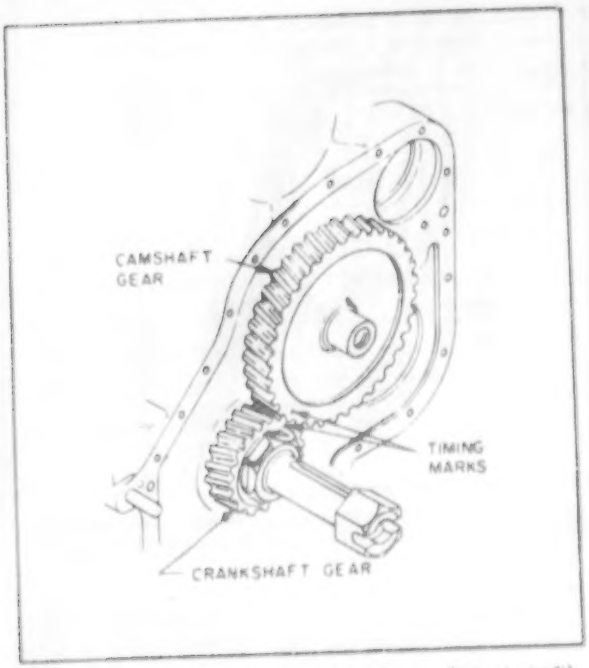


Figure 2-49. Indexing Timing Marks (Crankshaft)

2-264. REASSEMBLY. Reassemble in the reverse order of disassembly. Replace thermostat with V notch at top to vent as much air as possible.

2-265. AIR INTAKE MANIFOLD ASSEMBLY AND EXHAUST MANIFOLD ASSEMBLY.

2-266. SPECIAL TOOLS. No special tools are required to overhaul the air intake manifold and exhaust manifold assemblies.

2-267. DISASSEMBLY. Disassemble assemblies in accordance with figures 2-55 and 2-56.

2-268. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661. Dry with clean, filtered, compressed air.

2-269. INSPECTION. Inspect manifolds for cracks and distortion. Inspect gaskets and plugs for damage and corrosion.

2-270. TESTING. No testing is required.

2-271. REPAIR OR REPLACEMENT. Replace manifold components that are defective.

2-272. LUBRICATION. No lubrication is required.

2-273. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-274. WATER MANIFOLD ASSEMBLY.

2-275. SPECIAL TOOLS. No special tools are required for overhaul of the water manifold assembly.

2-276. DISASSEMBLY. Disassemble the water manifold assembly in accordance with figure 2-57.

2-277. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

2-278. INSPECTION.

a. Inspect all parts for wear.

b. Check operation of drain cock.

c. Inspect manifolds and couplings for cracks.

2-279. TESTING. No testing is required.

2-280. REPAIR OR REPLACEMENT. Replace cracked, worn, and damaged components. Replace preformed packing at each overhaul interval.

2-281. LUBRICATION. No lubrication is required.

2-282. REASSEMBLY. Reassemble in the reverse order of disassembly. Replace with new gaskets.

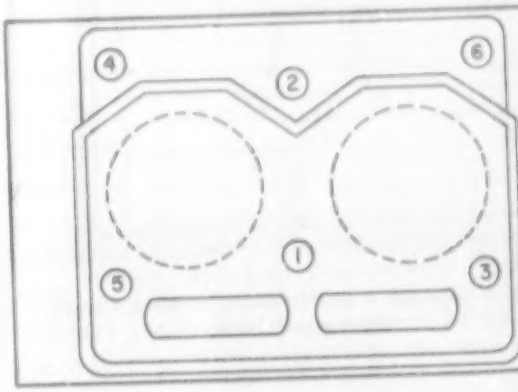


Figure 2-50. Sequence for Tightening Cylinder Head Capscrew

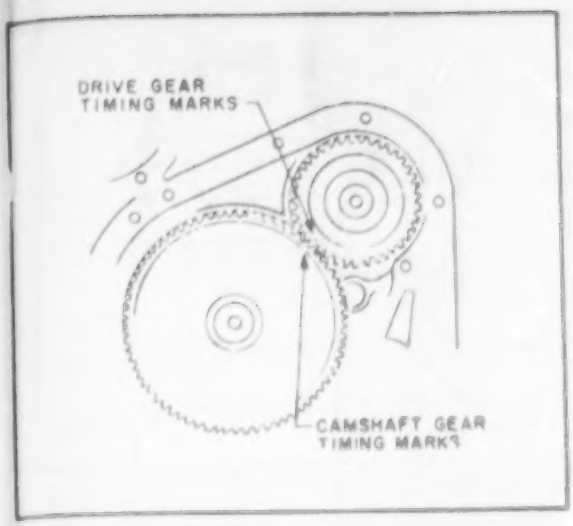


Figure 2-51. Indexing Timing Marks (Camshaft)

2-283. WATER PUMP AND FAN HUB ASSEMBLY.

2-284. SPECIAL TOOLS. No special tools are required for overhaul of the water pump and fan hub assembly.

2-285. DISASSEMBLY. Disassemble the water pump and fan hub assembly in accordance with figure 2-58.

NOTE

Presence of a new part in the applicable kit eliminates the necessity of cleaning, inspecting, or reworking the used part. Residue from kits and removed parts in this category shall be administratively condemned. The instructions which follow cover removed parts not supplied in kits and kitted parts (if any) which require cleaning, inspecting, or testing prior to installation.

2-286. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

NOTE

Be sure all traces of grease are removed.

2-287. INSPECTION.

a. Inspect inner and outer water pump bearings.

b. Inspect water pump impeller (20). Measure impeller bore and shaft OD. There must be a minimum of 0.0015 inch clearance between shaft and impeller.

c. Inspect water pump body (29) seal face.

d. Inspect water pump mounting parts for cracks.

e. Examine carbon seal (21) carefully to make sure it is not cracked or chipped.

f. Examine fan drive belt (5) for damage.

g. Check pipe lugs for corrosion.

2-288. TESTING. No testing is required.

2-289. REPAIR OR REPLACEMENT.

a. Replace worn bearings.

b. Replace water pump body seal face.

c. Replace cracked or corroded pump impeller.

d. Replace defective carbon seal.

e. Replace remaining parts exhibiting excessive wear or damage.

2-290. LUBRICATION. No lubrication is required.

2-291. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-292. GEAR CASE COVER ASSEMBLY.

2-293. SPECIAL TOOLS. No special tools are required for overhaul of the gear case cover assembly.

2-294. DISASSEMBLY. Disassemble the gear case cover assembly in accordance with figure 2-59.

NOTE

Use a standard driving tool to remove bushing if necessary.

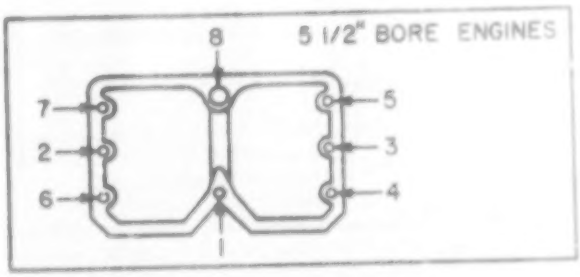
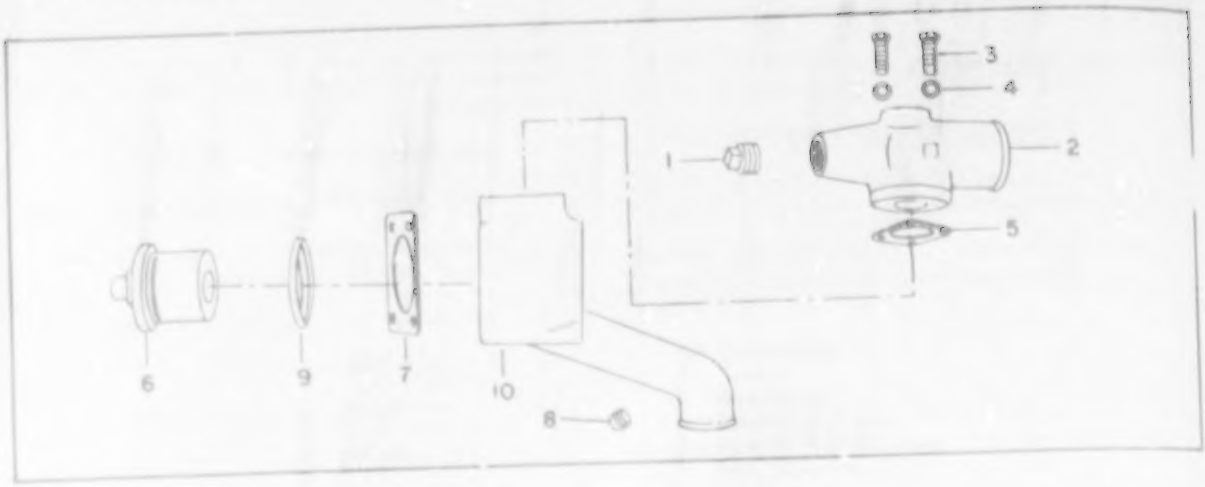


Figure 2-52. Sequence for Tightening Rocker Housing



1. Pipe Plug
2. Water Outlet Connection
3. Screw
4. Lock Washer
5. Gasket
6. Thermostat
7. Gasket
8. Pipe Plug
9. Thermostat Seal
10. Thermostat Housing

Figure 2-53. Thermostat Housing Assembly

2-295. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

c. Steam clean internal components after solvent rinse.

d. Dry with clean, dry, compressed air.

2-296. INSPECTION.

a. Inspect cover for cracks.

b. Check bushing for nicks, scores, and scratches.

c. Inspect seal bore.

d. Check thrust plate.

2-297. TESTING. No testing is required.

2-298. REPAIR OR REPLACEMENT. Replace all worn, cracked, and otherwise defective parts. Replace shims (9) and packing (7) at each overhaul interval.

2-299. LUBRICATION. No lubrication is required.

2-300. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-301. LUBRICATING OIL FILTER ASSEMBLY.

2-302. SPECIAL TOOLS. No special tools are required for overhaul of the lubricating oil filter assembly.

2-303. DISASSEMBLY. Disassemble the lubricating oil filter assembly in accordance with figure 2-80.

2-304. CLEANING. Clean inside of filter shell with cleaning solvent, Federal Specification P-S-661. Wipe dry with a lint free cloth.

2-305. INSPECTION.

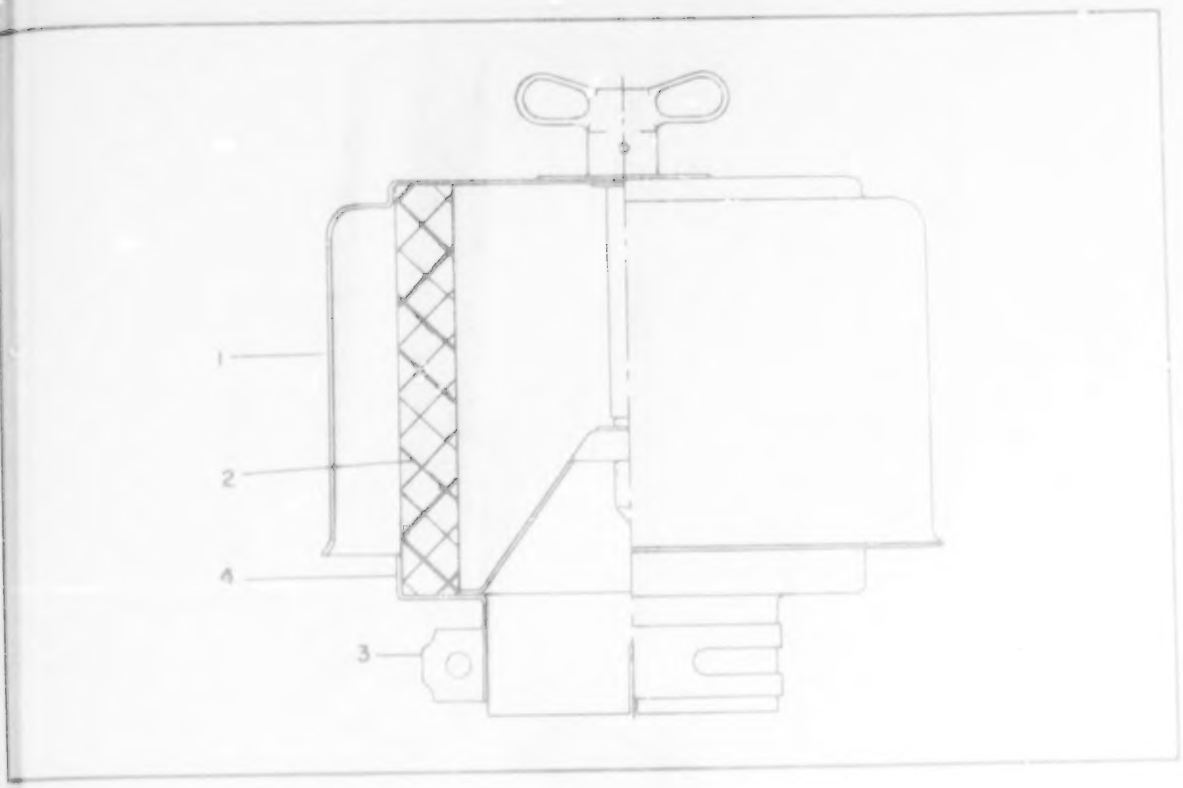
a. Examine filter shell (4) for physical damage, paying particular attention to sealing area.

b. Inspect mounting bolt seal (7) and threads of mounting bolts.

c. Check orifice in standpipe.

2-306. TESTING. No testing is required.

2-307. REPAIR OR REPLACEMENT. Replace any item noted defective during inspection. Replace cartridge.



1. Breather Hood
2. Breather Element
3. Breather Clamp
4. Breather Base

Figure 2-54. Crankcase Breather Assembly

2-308. LUBRICATION. No lubrication required.

2-309. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-310. LUBRICATION OIL PUMP ASSEMBLY.

2-311. SPECIAL TOOLS. No special tools are required for overhaul of the lubricating oil pump assembly.

2-312. DISASSEMBLY. Disassemble the lubricating oil pump assembly in accordance with figure 2-61.

CAUTION

Spring tension on pressure regulator may cause assembly to fly from body if released suddenly. If necessary tap pressure regulator cap lightly with soft hammer to release plug (17, figure 2-61), remove spring (22) and plunger (18).

2-313. CLEANING.

a. Clean all parts with dry cleaning solvent, Federal Specification P-S-661. Dry with compressed air.

b. Remove all gasket residue from mounting surfaces.

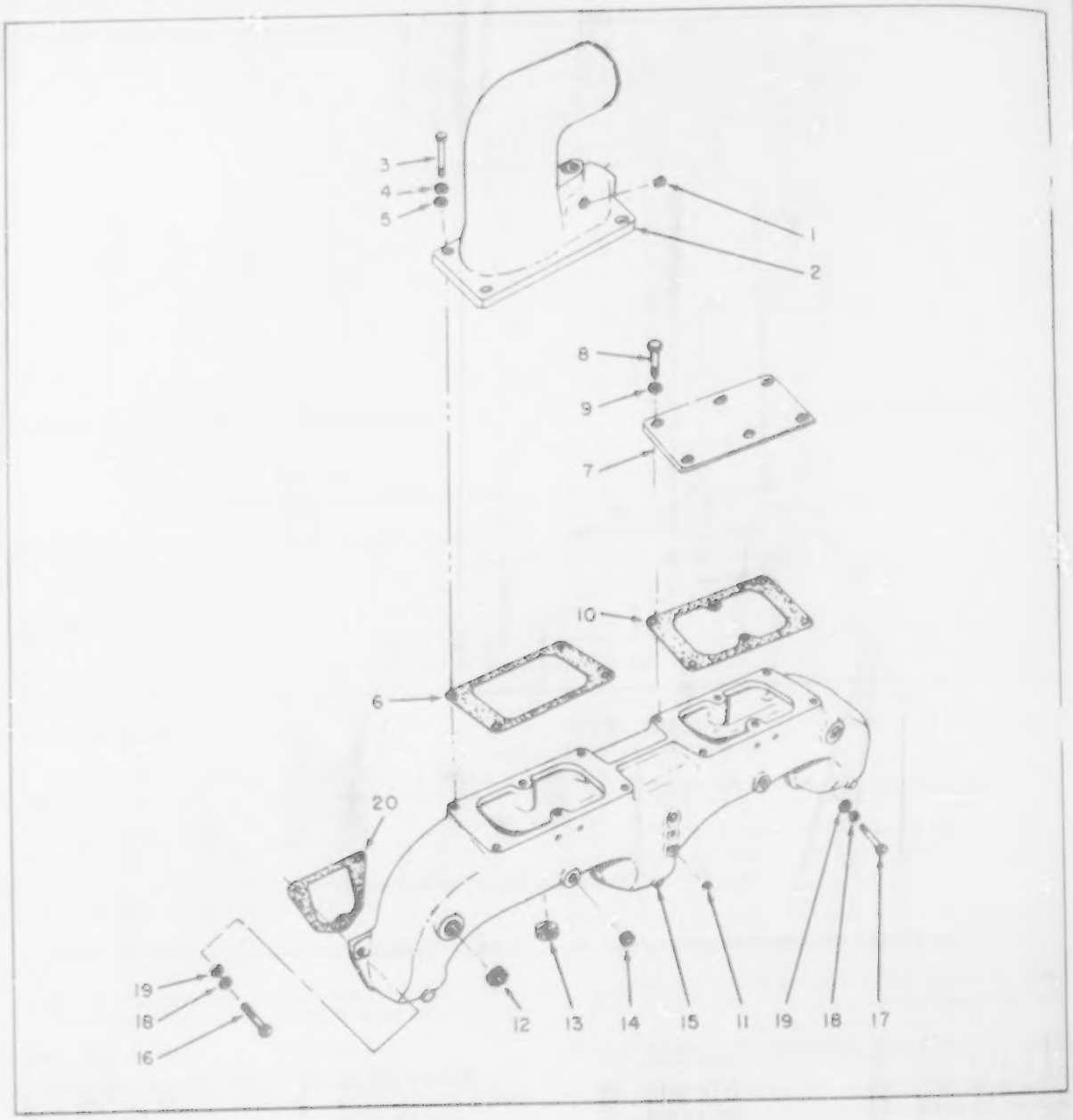
2-314. INSPECTION.

a. Inspect all gears for worn or broken teeth.

b. Examine parts for burrs, pitting, rusting, scoring, cracks, breaks, and distorted threads.

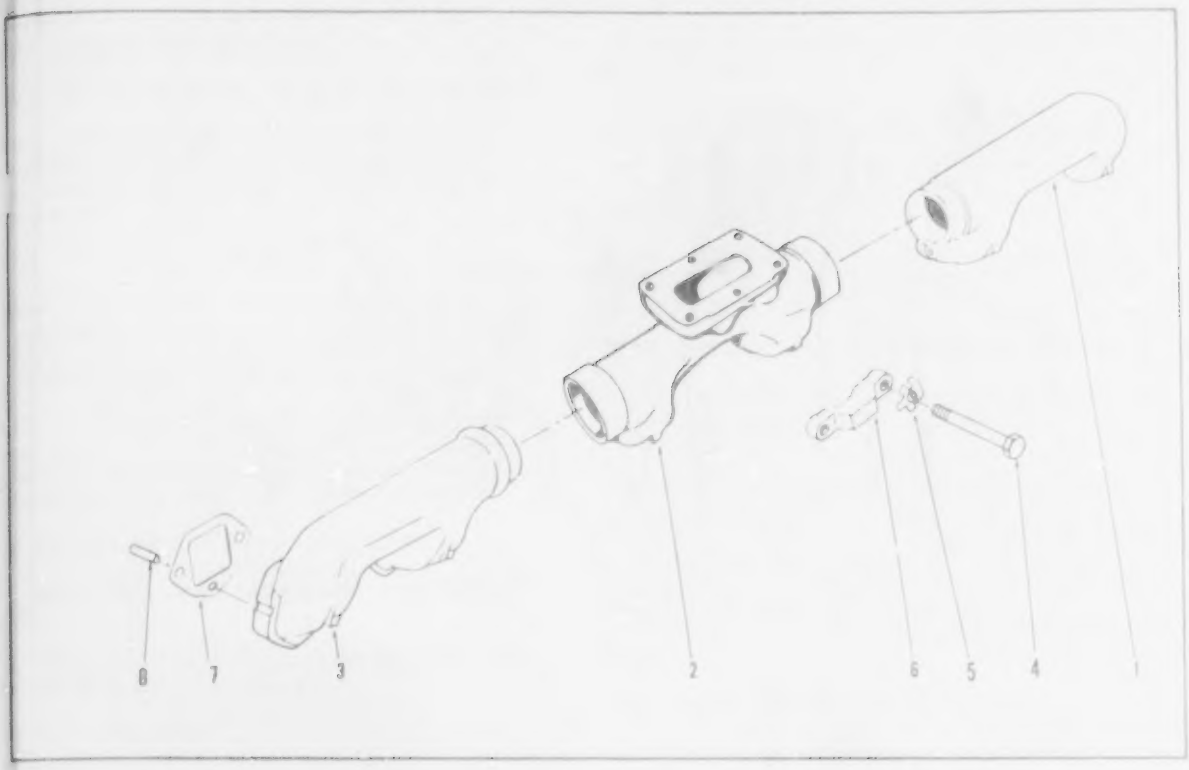
c. Inspect bushings in pump body, filter head, and idler gear. Replace if worn larger than 0.8185 inches (ID).

d. Inspect idler shaft. Replace shaft if shaft has turned in pump body or if worn smaller than 0.8145 inches (OD) in bushing area of shaft.



1. Pipe Plug
2. Air Manifold Connector
3. Hex. Hd Cap Screw
4. Lock Washer
5. Flat Washer
6. Gasket
7. Manifold Access Cover
8. Hex. Hd Cap Screw
9. Lock Washer
10. Gasket
11. Plug
12. Pipe Plug
13. Pipe Plug
14. Pipe Plug
15. Air Intake Manifold
16. Hex. Hd Cap Screw
17. Hex. Hd Cap Screw
18. Lock Washer
19. Washer
20. Gasket

Figure 2-55. Air Intake Manifold Assembly



1. Front Exhaust Manifold
2. Center Exhaust Manifold
3. Rear Exhaust Manifold
4. Hex. Hd Cap Screw
5. Lock Plate
6. Manifold Exhaust Clamp
7. Gasket
8. Headless Straight Pin

Figure 2-56. Exhaust Manifold Assembly

e. Inspect drive shaft. Replace if shaft has turned in gears or worn smaller than 0.6145 inches (OD).

f. Check all mating surfaces for flatness.

g. Test regulator plunger in pump body for binding.

2-315. TESTING. No testing required.

2-316. REPAIR OR REPLACEMENT.

a. Replace item noted defective during inspection.

b. If front bushing (2) is removed, press in pump body flush to 0.030 inches below front surface. Press drive shaft rear bushing 0.020 - 0.050 inches below rear surfaces.

c. If idler gear bushings are removed, press in idler gear 0.005 - 0.015 inches below surface of gear.

d. Bore or line ream new bushings to 0.6165 - 0.6175 inches ID.

e. Replace dowels (7) if removed.

2-317. LUBRICATION.

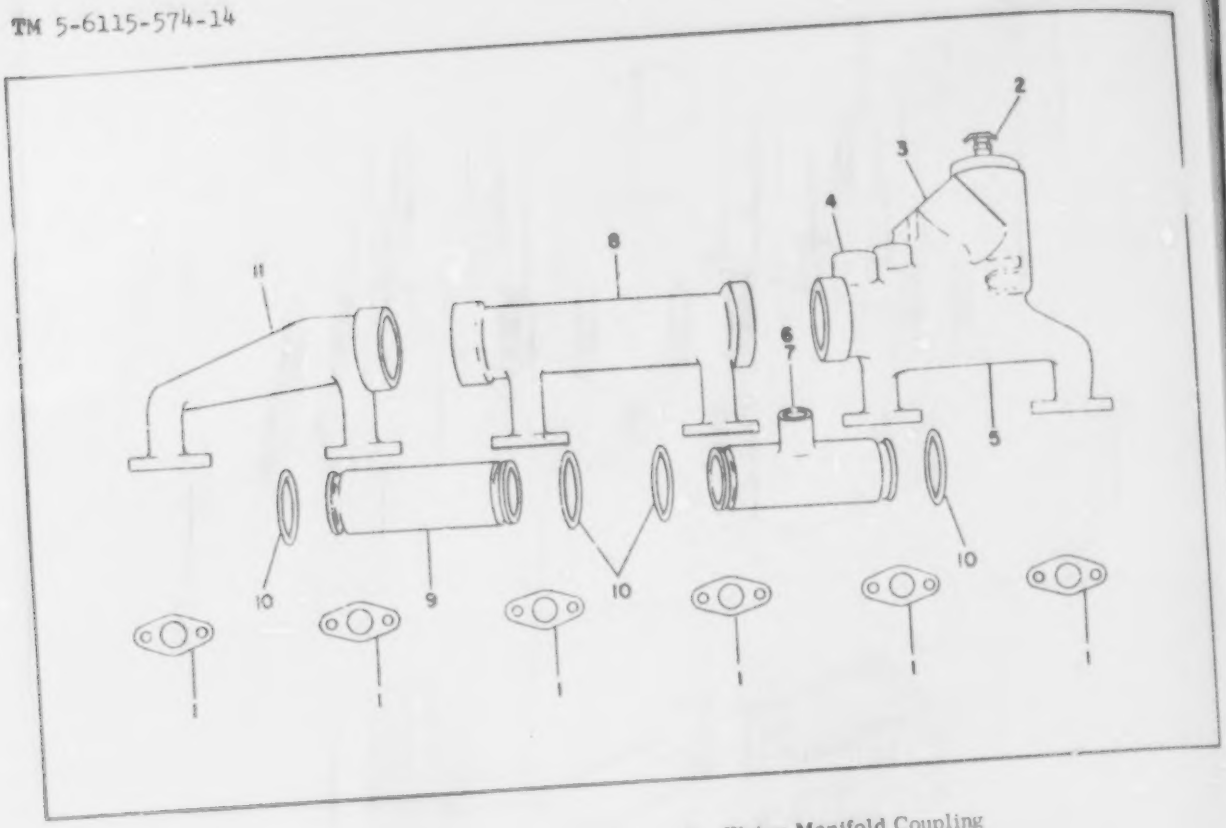
2-318. REASSEMBLY.

a. Press large end of idler shaft (20) in gear pocket side of pump body. Shaft should protrude 0.720 - 0.740 inches.

b. Press drive gear (9) onto drive shaft (19). Shaft should protrude 0.855 - 0.875 inches.

c. Slide driveshaft and gear into pump body.

d. Press drive gear (10) onto drive shaft.



1. Gasket
2. Vent Cock
3. Pipe Plug
4. Pipe Plug
5. Front Manifold
6. Coupling
7. Water Manifold Coupling
8. Center Manifold
9. Water Manifold Coupling
10. Preformed Packing
11. Rear Manifold

Figure 2-57. Water Manifold Assembly

NOTE

Using a 0.012 inch shim between rear surface of drive gear and front surface of pump body, press gear snug. Remove shim.

e. Install idler gear on idler shaft.

f. Install new dowels (7) in pump body, if removed.

g. Install dowel ring in oil outlet hole with beveled edge up.

h. Install filter head and new gasket over dowel in pump body. Secure with lockwashers and capscrews.

i. Check drive shaft end play. It should be 0.002 - 0.004 inch.

j. Install pipe plugs in filter head and pump body.

k. Install spring (21) in pressure regulator plunger open end (18).

l. Install pressure regulator plunger assembly in pump body, solid end of plunger down.

m. Install new O-ring on pressure regulator cap (15) used on grooved cap only.

n. Place cap over pressure regulator spring and push cap into pump body. Secure with holddown clamp (23), lockplate (12) and capscrew (3).

CAUTION

Be sure pressure cap is not cocked in pump body or oil leakage may occur.

o. With new gasket, position oil inlet connection to pump body. Secure with lockwashers and capscrews.

p. Install pipe plug in oil inlet connection.

FUEL PUMP ASSEMBLY.

SPECIAL TOOLS. No special tools required.

DISASSEMBLY. Dismantle fuel pump in ance with figure 2-62. Overhaul the fuel ubassemblies as instructed in following aphs.

NOTE

el pump overhaul must be conducted in an remely clean shop area, dust free, temper- re controlled and all subassemblies once noved must be stored in clean metal trays.

. CLEANING. Clean all components of fuel , except the shutdown coil with dry cleaning nt, Federal Specification P-S-661. Then pro- as outlined below.

Dry with clean, filtered, compressed air.

Remove all gasket residue from mounting sur- s.

Wash inlet screen/magnet assembly with clean and flush with compressed air.

3. INSPECTION.

Examine for physical damage, cracked castings, ken mounting flange.

Inspect all threaded bores and fuel attachment ings for damaged threads or seats.

Inspect fuel pump drive coupling for security mounting.

Inspect fuel shutdown valve (4) attachment rdware and electrical connection studs.

Inspect fuel pump main shaft housing air vent ole.

For internal component inspection refer to fuel ump subassemblies as covered in subsequent para- graphs.

2-324. TESTING. General procedure is to func- tionally test the complete fuel pump assembly when reinstalled on the engine generator set and as part of the unit load tests in Section III. However a porosity test can be performed prior to pump reas- sembly onto the engine. Proceed as follows.

Fill fuel pump with clean diesel fuel.

Remove suction fitting at gear pump and in- stall fittings so an air pressure hose may be attached.

Air pressure hose line must be equipped with a valve and gage to regulate air pressure to a maximum of 20 psi.

d. Apply 20 psi air pressure. Do not exceed 20 psi or damage to seals may result.

e. Pour clean fuel over pump and examine care- fully for air bubbles, indicating leaks. Alternately wipe pump or specific area dry and check for wet seepage. Do not use this method as a check for seal condition.

2-325. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Replace all gaskets, seals, and o-rings.

2-326. LUBRICATION. No lubrication required.

2-327. REASSEMBLY. Reassemble in reverse order of disassembly. Note the following.

a. Make sure manual override adjustment screw on fuel shutdown solenoid valve is in the closed or C position. (Obtain by turning screw counterclock- wise). If the adjusting screw is in the open or O position, fuel will continue to flow to the injectors when the unit stop switch is thrown, and the engine will continue to run and cannot be electrically shut- down.

b. Torque filter cap to 25 foot pounds.

c. Torque gear pump assembly mounting screws to 9 foot pounds.

d. Tighten shutdown valve mounting screws to between 7 and 15 inch-pounds torque.

e. Tighten gear pump mounting capscrews to 40 foot pounds.

2-328. PRESSURE REGULATOR ASSEMBLY.

2-329. SPECIAL TOOLS. No special tools required.

2-330. DISASSEMBLY. Disassemble pressure regu- lator in accordance with figure 2-63.

2-331. CLEANING. Clean the various components of the pressure regulator assembly in dry cleaning fluid type Federal Specification P-S-661. Air dry with filtered, compressed air.

NOTE

Place all components in a pan of clean fuel oil or test oil while awaiting inspection or rebuild.

2-332. INSPECTION.

a. Inspect cap (1) for damaged threads.

b. Examine spring (12) for broken coil. Check for correct color code and overall length.

c. Inspect plunger bypass valve OD for signs of scoring.

d. Inspect ID of bypass sleeve (11).

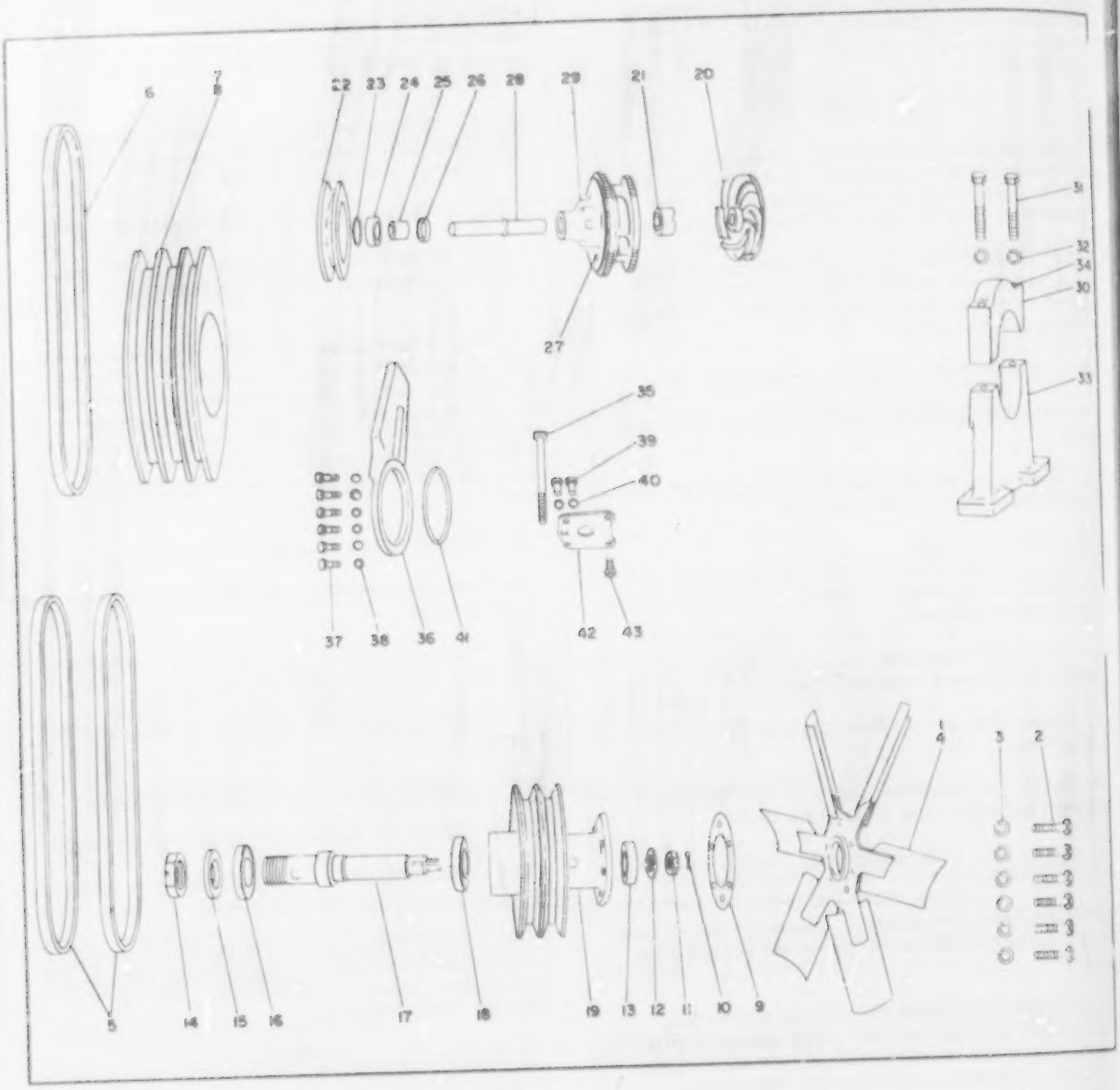


Figure 2-58. Water Pump and Fan Hub Assembly

Legend for figure 2-58

1. Engine Cooling Fan
2. Hex. Hd Cap Screw
3. Lock Washer
4. Sleeve Spacer
5. Fan Drive Belt
6. Water Pump Drive Belt
7. Groove Pulley
8. Pulley Sleeve
9. Gasket
10. Cotter Pin
11. Hex. Slotted Nut
12. Flat Washer
13. Annular Ball Bearing
14. Hex. Slotted Nut
15. Flat Washer
16. Fan Hub Oil Seal
17. Shouldered Shaft
18. Annular Ball Bearing
19. Grooved Pulley
20. Centrifugal Pump Impeller
21. Water Pump Seal
22. Groove Pulley
23. Retaining Ring
24. Annular Ball Bearing
25. Sleeve Spacer
26. Annular Ball Bearing
27. Pipe Plug
28. Shouldered Shaft
29. Water Pump Body
30. Engine Support Cap
31. Hex. Hd. Cap Screw
32. Lock Washer
33. Lower Support
34. Lubrication Fitting
35. Setscrew
36. Fan Bracket
37. Hex. Hd. Cap Screw
38. Lock Washer
39. Hex. Hd Cap Screw
40. Lock Washer
41. Gasket
42. Fan Bracket Support
43. Hex. Hd Cap Screw

2-333. TESTING. No testing required.

2-334. REPAIR OR REPLACEMENT. Replace any item noted defective during inspection. Always replace preformed packing (3, 4, 5) whenever this assembly has been removed from the fuel pump.

2-335. LUBRICATION. No lubrication required.

2-336. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-337. TACHOMETER DRIVE ASSEMBLY.

2-338. SPECIAL TOOLS. No special tools required.

2-339. DISASSEMBLY. Disassemble the tachometer drive assembly in accordance with figure 2-64. Pay particular attention to the following.

Tachometer drive bushing (1) is a press fit into the pump housing at upper 1/4 inch and must be removed as described.

a. Remove housing mounting capscrews (6).

b. Lift housing (7) and gasket (5) from housing. Discard gasket.

c. Use a collet with a dowel puller to pull tachometer seal (8), shaft (3), and bushing (1).

NOTE

It may be necessary to remove the shutdown valve from the fuel pump to provide necessary clearance to employ puller.

2-340. CLEANING. Clean the tachometer drive components in dry cleaning fluid type P-S-661. Air dry with filtered, compressed air.

2-341. INSPECTION. Inspect tachometer drive assembly as follows:

a. Inspect gear (2) for broken and damaged teeth.

b. Inspect shaft (3) for parallel alignment and absence of excessive wear in drive slot.

c. Inspect spacer (3A) for evidence of thrust wear.

d. Inspect seal (8) for both ID and OD wear patterns.

2-342. TESTING. No testing is required.

2-343. REPAIR OR REPLACEMENT. Replace items noted defective during inspection. Always replace both bushing (1) and seal (8) whenever this assembly has been removed from the fuel pump. Replace gasket (5).

2-344. LUBRICATION. No lubrication required.

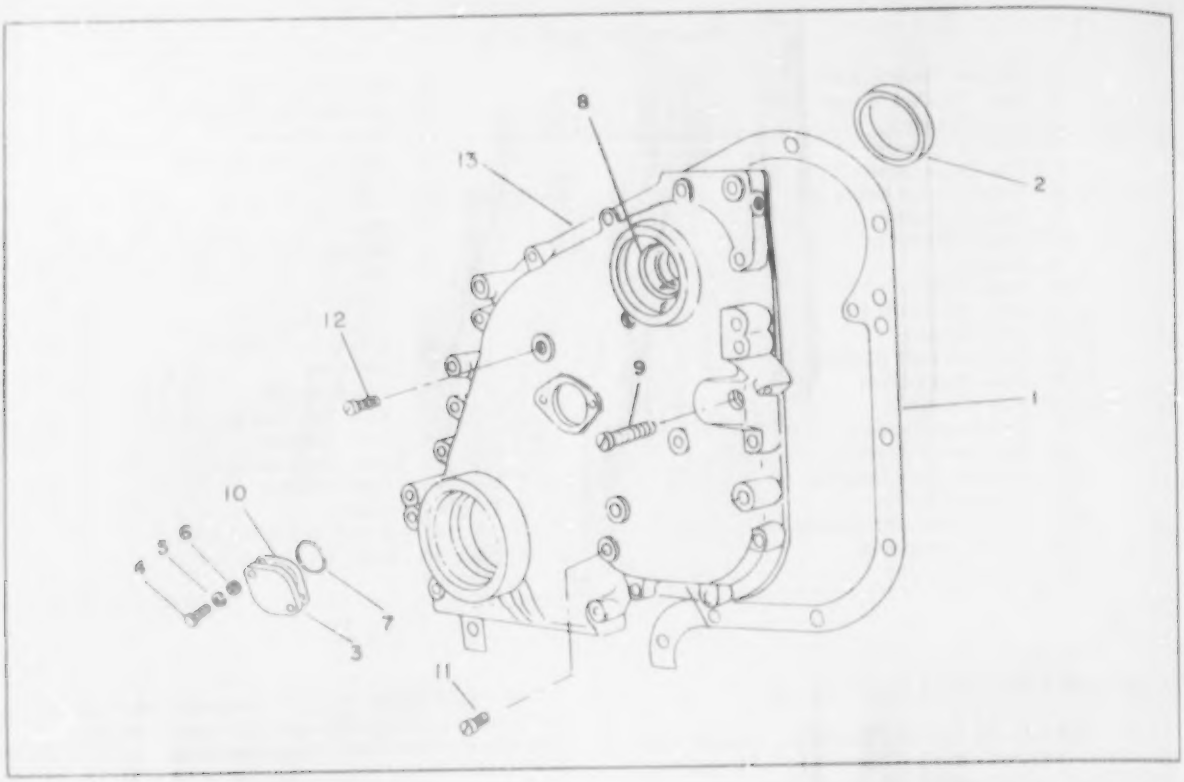
2-345. REASSEMBLY. Reassemble in the reverse order of disassembly. Note the following:

a. The bushing (1) and seal (8) must be installed separately.

b. Install the bushing (1) and shaft (3) in the housing using a plastic hammer.

NOTE

Rotate the shaft to be certain the gears mesh.



1. Gasket
2. Oil Accessory Drive Seal
3. Camshaft Thrust Plate
4. Hex. Hd Cap Screw
5. Lock Washer
6. Flat Washer
7. Preformed Packing
8. Fuel Pump Drive Bushing
9. Insert, Screw thread
10. Shim
11. Pipe Plug
12. Pipe Plug
13. Gear Case Cover

Figure 2-59. Gear Case Cover Assembly

c. Place the spacer (3A) on top of bushing with slot facing down against bushing.

d. Install the drive seal (8) with a mandrel until it bottoms.

CAUTION

Do not overpress. The spacer (3A) can be flattened eliminating its effectiveness.

2-346. FUEL PUMP FILTER ASSEMBLY.

2-347. DISASSEMBLY. Disassemble filter assembly in accordance with figure 2-65.

2-348. CLEANING. Clean filter and associated components in dry cleaning fluid type Federal Specification P-S-661. Air dry with low volume filtered, compressed air.

2-349. INSPECTION. Inspect filter components as follows:

a. Inspect filter cap (1) for damaged mounting threads and damaged installation slot.

b. Carefully examine filter screen assembly (2) for evidence of rupture, breakage, and screen separation.

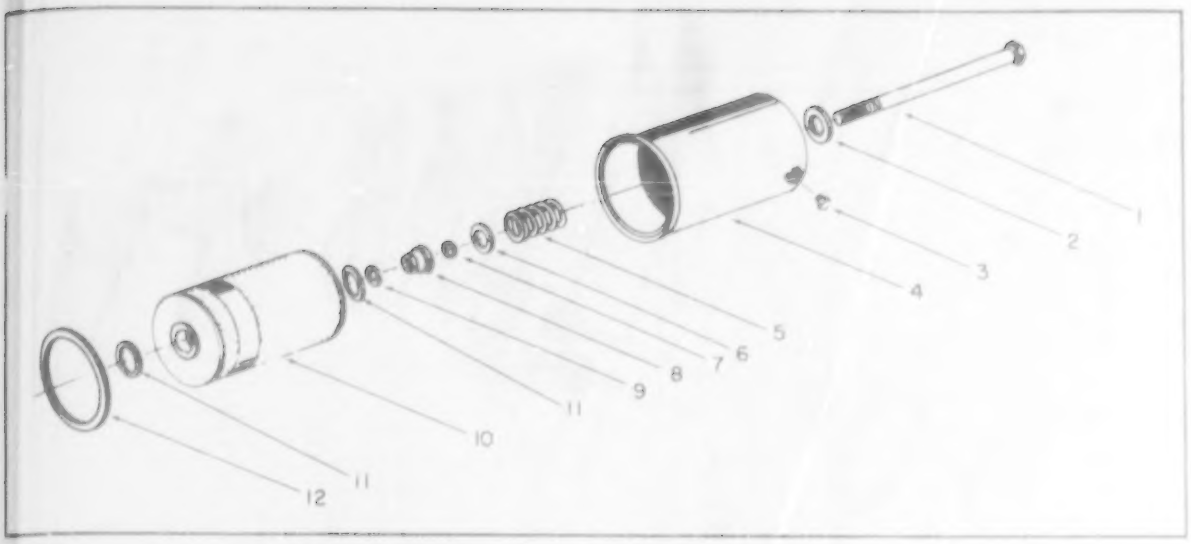
c. Inspect spring (4) for signs of coil breakage.

2-350. TESTING. No testing is required.

2-351. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Replace ring seal (3).

2-352. LUBRICATION. No lubrication is required.

2-353. REASSEMBLY. Reassemble in reverse order of disassembly.



1. Bolt
2. Gasket, Copper
3. Drain Plug
4. Shell
5. Cartridge Spring
6. Bolt Washer
7. Bolt Seal
8. Cartridge Support
9. Snap Ring
10. Cartridge
11. Cartridge Seal
12. Shell to Filter Head Seal

Figure 2-60. Lubricating Oil Filter Assembly

2-354. SHUTDOWN VALVE ASSEMBLY.

2-355. DISASSEMBLY. Disassemble shutdown valve in accordance with figure 2-66. Discard preformed packing (6 and 7) and ring seal (15).

2-356. CLEANING. Clean shutdown valve mechanical components with dry cleaning fluid type Federal Specification P-S-661.

CAUTION

Do not permit this type of cleaning fluid to come in contact with the electrical coil assembly (2). Clean the coil assembly by wiping with a dry lint free cloth.

2-357. INSPECTION. Inspect shutdown valve components in following manner.

a. Examine valve housing (3) for evidence of cracks and casting porosities.

b. Inspect valve (12) and spring (11) for rust and corrosion.

c. Inspect override knob (4) and override shaft (9) for parallel alignment.

d. Inspect coil (2) for evidence of damaged insulation.

2-358. TESTING. Test the shutdown valve as follows:

a. Test continuity of coil assembly with a volt-ohmmeter.

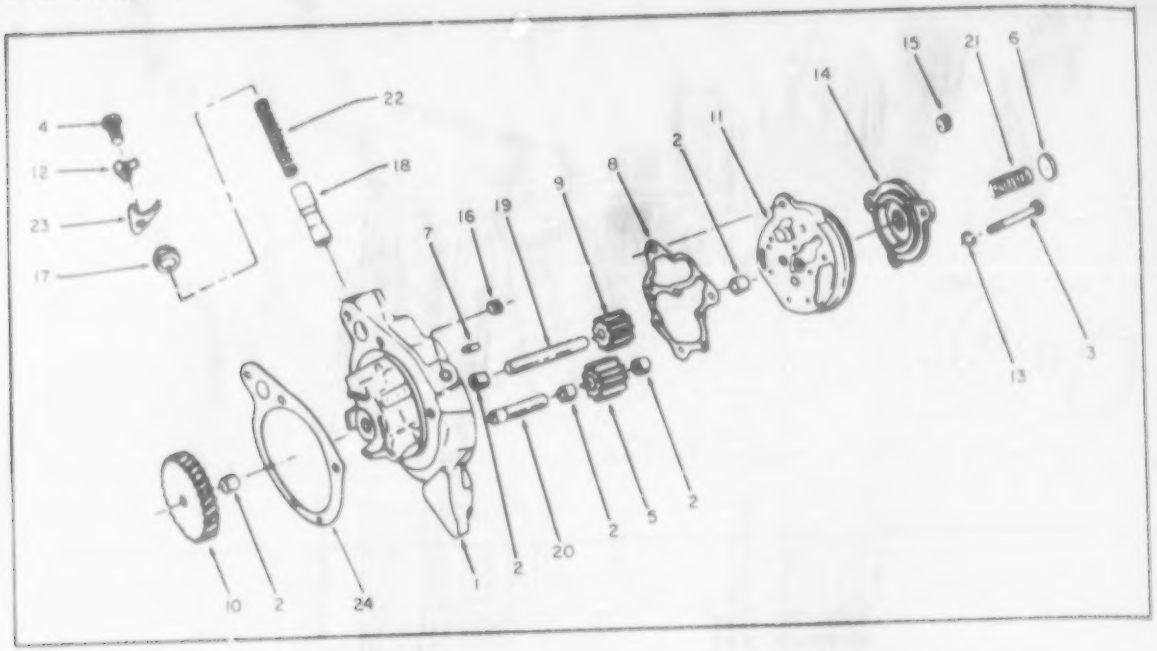
b. Apply 24 vdc (negative ground) to the coil terminals and listen to valve action.

c. Test manual override mechanism by removing dc electrical power supply and observing fuel flow through the valve assembly when the override knob is turned fully clockwise.

2-359. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Replace preformed packing (6 and 7) and ring seal (15).

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.



1. Body and Bushing
2. Bushing
3. Hex. Hd Cap Screw
4. Hex. Hd Cap Screw
5. Idler Gear
6. By-Pass Disc
7. Dowel
8. Filter Head Gasket
9. Drive Gear
10. Main Drive Gear
11. Filter Head
12. Lockplate
13. Lockwasher
14. Filter Head Plate
15. Pipe Plug
16. Pipe Plug
17. By Pass Valve Plug
18. Plunger
19. Drive Shaft
20. Idler Shaft
21. Spring
22. Spring
23. Yoke
24. Gasket

Figure 2-61. Lubricating Oil Pump Assembly

2-360. LUBRICATION. No lubrication is required.

2-361. REASSEMBLY. Reassemble in the reverse order of disassembly

2-362. FUEL PUMP DAMPER ASSEMBLY.

2-363. DISASSEMBLY. Disassemble damper in accordance with figure 2-67. Discard preformed packing (5 and 6) and ring seal (8).

2-364. CLEANING. Clean damper assembly components with dry cleaning solvent, Federal Specification P-S-661. Dry with filtered, low pressure, compressed air.

2-365. INSPECTION.

a. Inspect body (1) and plate (7) for physical damage and porosity.

b. Inspect internal threaded part in body (1) for damaged threads.

c. Examine diaphragm (3) for evidence of fatigue, cracks, and tears.

2-366. TESTING. No testing is required.

2-367. REPAIR OR REPLACEMENT. Replace items noted defective during the inspection. Replace preformed packing (5 and 6) and ring seal (6).

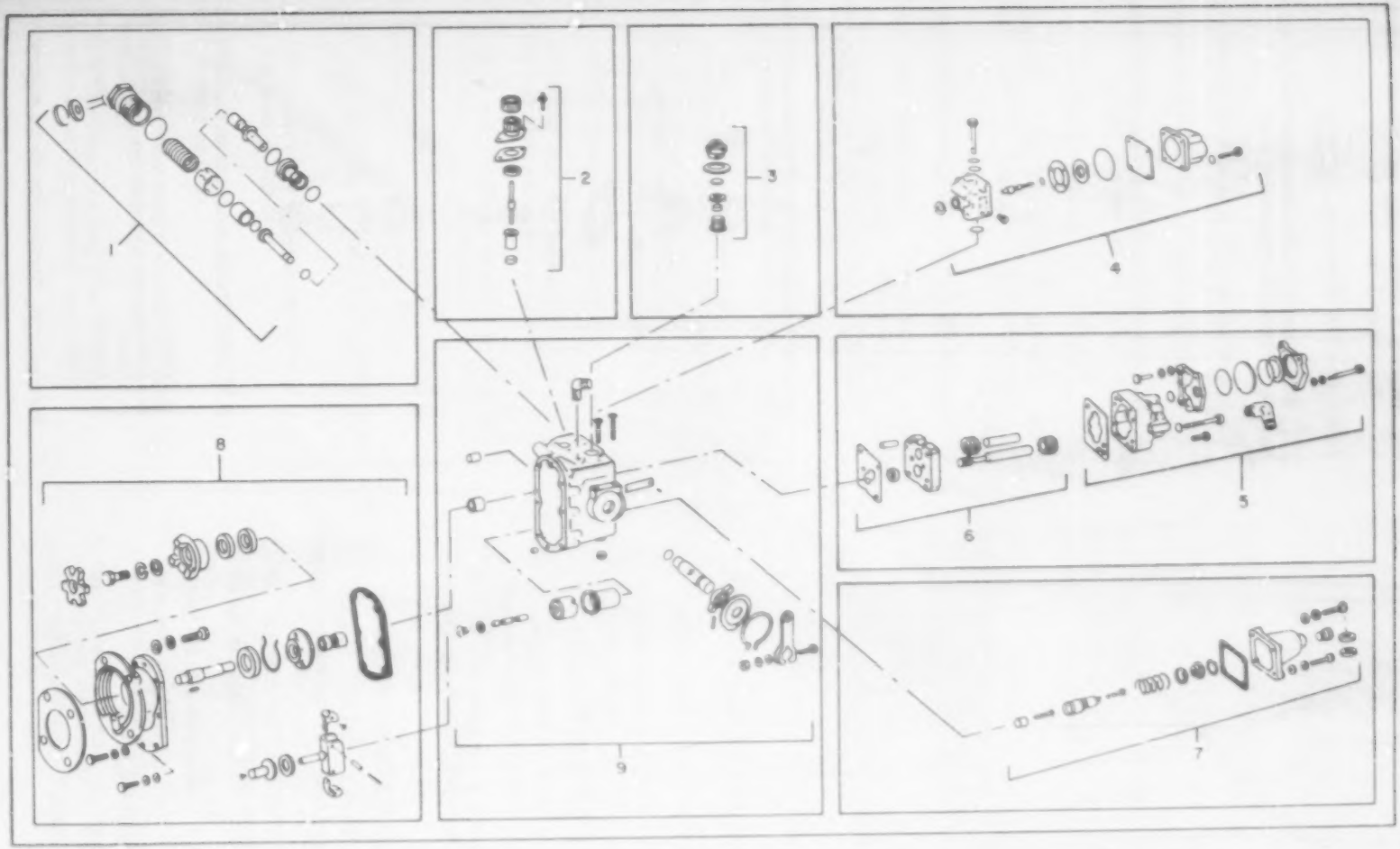
2-368. LUBRICATION. No lubrication is required.

2-369. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-370. GEAR PUMP ASSEMBLY.

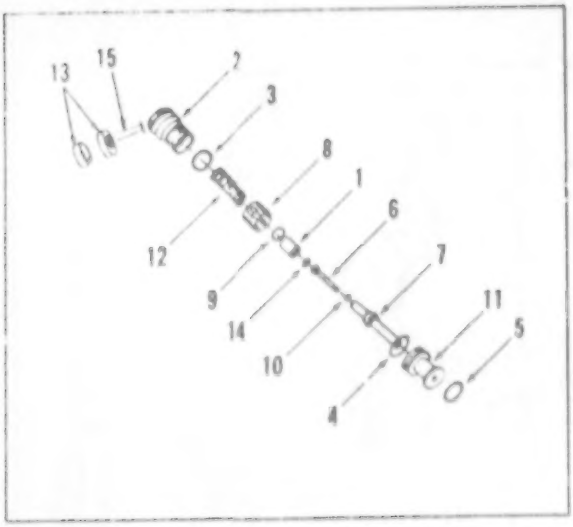
2-371. DISASSEMBLY. Disassemble gear pump in accordance with figure 2-68.

2-372. CLEANING. Clean gear pump components with dry cleaning solvent type Federal Specification P-S-661. Dry with filtered, low pressure, compressed air.



1. Pressure Regulator
2. Tachometer Drive Assembly
3. Filter
4. Shut Down Valve
5. Dampener
6. Gear Pump Assembly
7. Governor Spring Pack
8. Governor, Mainshaft and Cover
9. Housing

Figure 2-62. Fuel Pump Assembly



1. Cap
2. Cap
3. Packing Preformed
4. Packing Preformed
5. Packing Preformed
6. Plunger
7. Plunger
8. Ring
9. Shim by Pass Valve
10. Shim Fuel Adjustment Plunger
11. Sleeve
12. Spring
13. Seal
14. Lockwasher
15. Seal Wire

Figure 2-63. Pressure Regulator Assembly

2-373. INSPECTION.

a. Inspect cover and bearing assembly (1) for signs of excessive wear and cracks.

b. Inspect gears (7) and gear shaft (10) for chipped and broken teeth.

c. Inspect cover and bearing assembly (1) inlet port for broken and damaged threads and elbow (13) seat and threads.

2-374. TESTING. No testing is required.

2-375. REPAIR OR REPLACEMENT. Replace items noted defective during the inspection. Replace gaskets (6 and 14) paying particular attention to thickness of original components.

2-376. LUBRICATION. No lubrication is required.

2-377. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-378. GOVERNOR SPRING PACK.

2-379. DISASSEMBLY. Disassemble governor spring pack in accordance with figure 2-69. Discard gasket (17).

2-380. CLEANING. Clean various components of governor pack with dry cleaning solvent type Federal Specification P-S-661. Dry with filtered, low pressure, compressed air.

2-381. INSPECTION.

a. Check cover (1) for cracks and broken mounting holes and threads in adjustment bore.

b. Inspect springs (3, 6, and 9) for broken coils.

c. Inspect snap ring (11) for security of mounting.

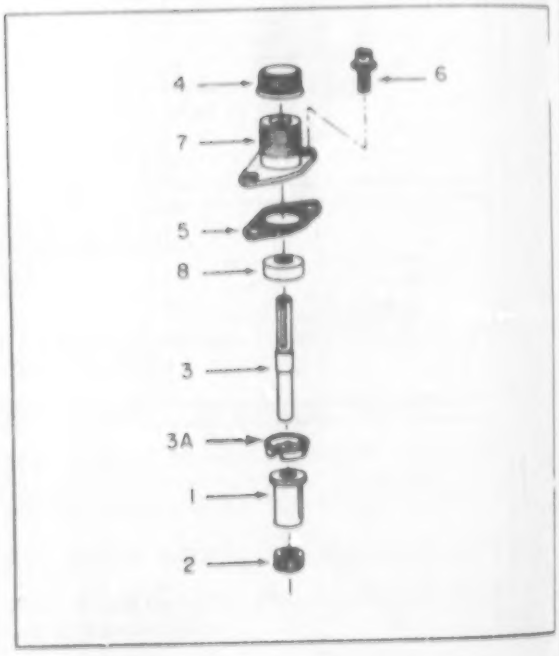
d. Examine plunger (10) together with guide and clip assembly (4) for evidence of binding.

2-382. TESTING. No testing is required.

2-383. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Replace gasket (17).

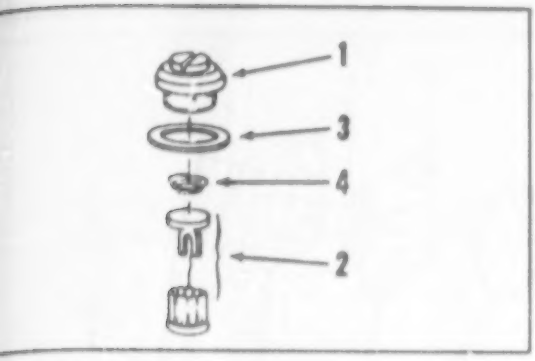
2-384. LUBRICATION. No lubrication is required.

2-385. REASSEMBLY. Reassemble in the reverse order of disassembly.



1. Bushing
2. Gear
3. Shaft
3A. Spacer
4. Cap
5. Gasket
6. Screw
7. Housing
8. Seal

Figure 2-64. Tachometer Drive Assembly



1. Cap
2. Filter Screen
3. Seal Ring
4. Spring

Figure 2-65. Fuel Pump Filter Assembly

-386. MAINSHAFT COVER AND GOVERNOR ASSEMBLY.

-387. DISASSEMBLY. Disassemble mainshaft over and governor assembly in accordance with igure 2-70.

-388. CLEANING. Clean various components of ainshaft cover and governor assembly in dry clean- g solvent type Federal Specification P-S-661. Dry ith filtered, low pressure, compressed air.

-389. INSPECTION.

a. Inspect cover and seal assembly (3) for cracks nd broken and damaged mounting holes.

b. Inspect seal (4) for evidence of dirt and ex- essive ID wear.

c. Inspect bearing (5) for rough spots and rust ontamination.

d. Examine gears (6, 7, and 11) for broken and hipped teeth.

e. Examine fuel pump drive shaft (8) for a worn ey way and wear on OD.

f. Check bushing governor weight shaft (9) for vidence of wear on OD.

g. Inspect governor weight carrier for loose pin 12), and chipped and damaged weights (15).

h. Check fuel pump coupling (29) for broken ingers and for correct material composition.

-390. TESTING. No testing is required.

2-391. REPAIR OR REPLACEMENT. Replace any items noted defective during the inspection.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.

2-392. LUBRICATION. No lubrication is required.

2-393. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-394. FUEL PUMP HOUSING ASSEMBLY.

2-395. DISASSEMBLY. Disassemble fuel pump housing in accordance with figure 2-71.

2-396. CLEANING. Clean various components of fuel pump housing by washing in dry cleaning solvent, type Federal Specification P-S-661. Dry with low volume, filtered, compressed air.

2-397. INSPECTION.

a. Inspect housing (1) for cracks and signs of porosity.

b. Barrel and sleeve assembly (2) for evidence of wear.

c. Check tachometer bushing (3) for wear on ID.

d. Examine spring pack housing (6).

e. Examine governor plunger (9), pin (8), and driver (7) for signs of excessive assembly tolerances.

f. Inspect throttle shaft (13) for wear and port cleanliness.

g. Inspect all threaded bores throughout the fuel pump housing.

h. Check fuel outlet elbow (17) for damaged threads and seat.

i. Examine adjusting set screws (25) for damaged threads and correct dimensions.

2-398. TESTING. No testing is required.

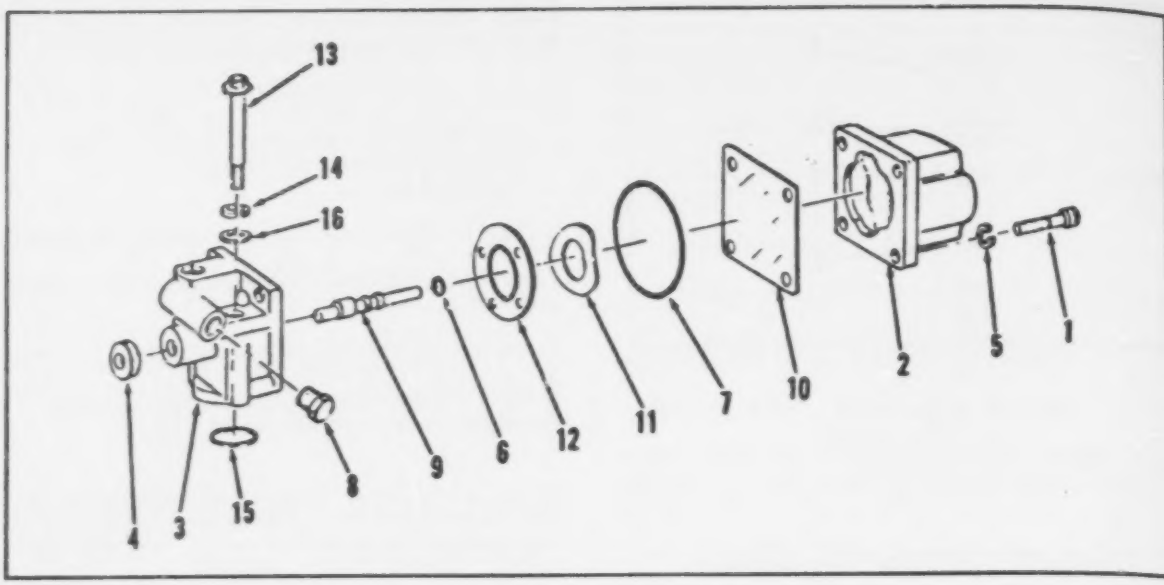
2-399. REPAIR OR REPLACEMENT. Replace any item noted defective during inspection.

NOTE

Only authorized parts shall be used as specified in the related Illustrated Parts Manual.

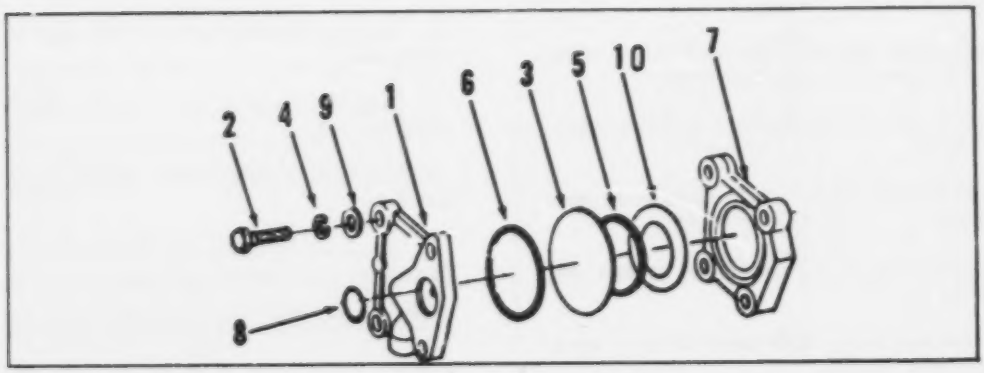
2-400. LUBRICATION. No lubrication is required.

2-401. REASSEMBLY. Reassemble in the reverse order of disassembly.



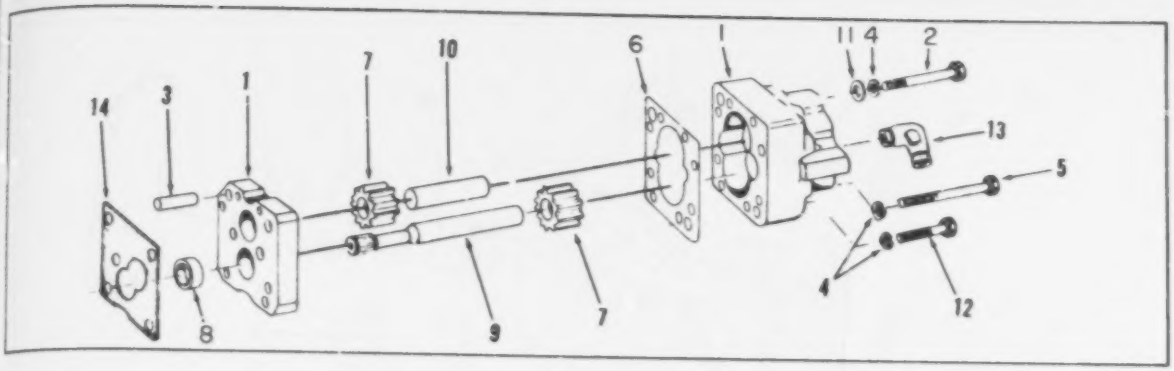
1. Screw
2. Coil
3. Valve Housing
4. Override Knob
5. Lockwasher
6. Packing Preformed
7. Packing Preformed
8. Plug
9. Override Shaft
10. Shield
11. Spring
12. Valve
13. Screw
14. Lockwasher
15. Seal Ring
16. Washer

Figure 2-66. Shutdown Valve Assembly



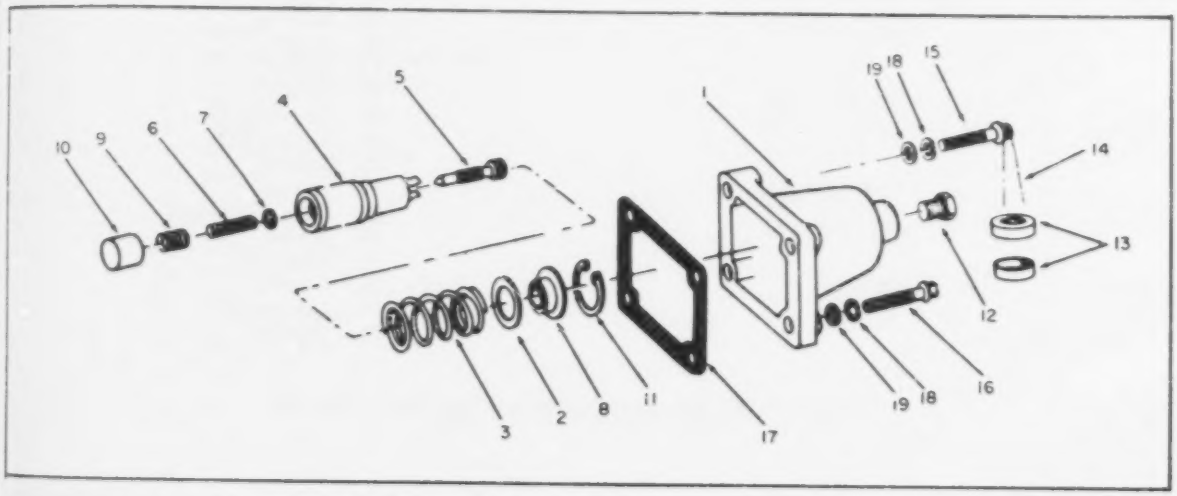
1. Body
2. Screw
3. Diaphragm
4. Lockwasher
5. Packing Preformed
6. Packing Preformed
7. Plate
8. Seal Ring
9. Washer
10. Washer

Figure 2-67. Fuel Pump Damper Assembly



1. Cover and Bearing Assembly
2. Screw
3. Dowel
4. Lockwasher
5. Screw
6. Gasket
7. Gear
8. Ring Dowel
9. Drive Shaft
10. Gear Shaft
11. Washer
12. Screw
13. Elbow
14. Gasket

Figure 2-68. Gear Pump Assembly



1. Cover
2. Shim
3. Spring
4. Guide and Clip Assembly
5. Screw Idle Adjustment
6. Inner Idling Spring
7. Washer
8. Retainer
9. Outer Idling Spring
10. Plunger
11. Snap Ring
12. Plug
13. Seal
14. Seal Wire
15. Screw
16. Screw
17. Gasket
18. Lockwasher
19. Washer

Figure 2-69. Governor Spring Pack

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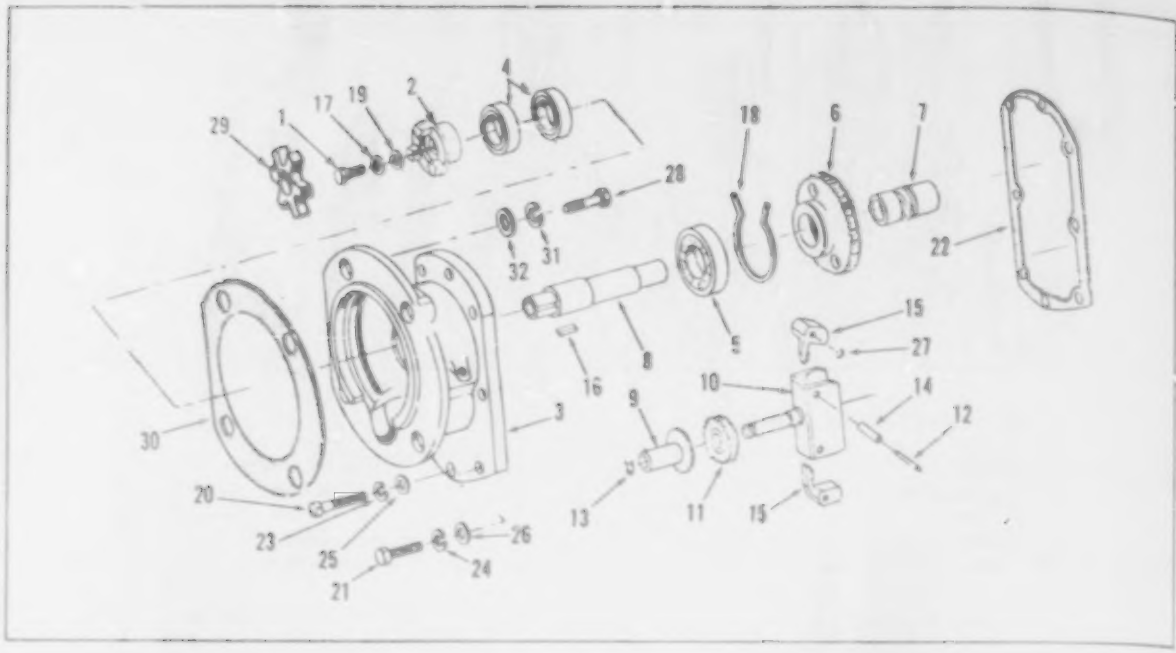


1. Coupling Capscrew
2. Coupling Half
3. Cover and Seal Assembly
4. Seal
5. Bearing
6. Gear Fuel Pump Drive
7. Gear Tachometer Drive
8. Shaft
9. Bushing
10. Governor Weight Carrier
11. Gear
12. Pin
13. Ring
14. Governor Weight
15. Governor Weight
16. Key
17. Lockwasher
18. Ring
19. Washer
20. Screw
21. Screw
22. Gasket
23. Lockwasher
24. Lockwasher
25. Washer
26. Washer
27. Thrust Washer
28. Screw
29. Coupling
30. Gasket
31. Lockwasher
32. Washer

Figure 2-70. Mainshaft Cover and Governor Assembly

2-402. FUEL PUMP DRIVE ASSEMBLY.

2-403. DISASSEMBLY. Disassemble fuel pump drive in accordance with Figure 2-72.

2-404. CLEANING. Clean the components of this assembly by washing in dry cleaning solvent Federal Specification P-S-661. Wipe with lint free cloth and dry with filtered, low pressure, compressed air.

2-405. INSPECTION.

a. Examine gear (3) for broken and damaged teeth.

b. Inspect housing (4) for cracks and broken mounting flange holes.

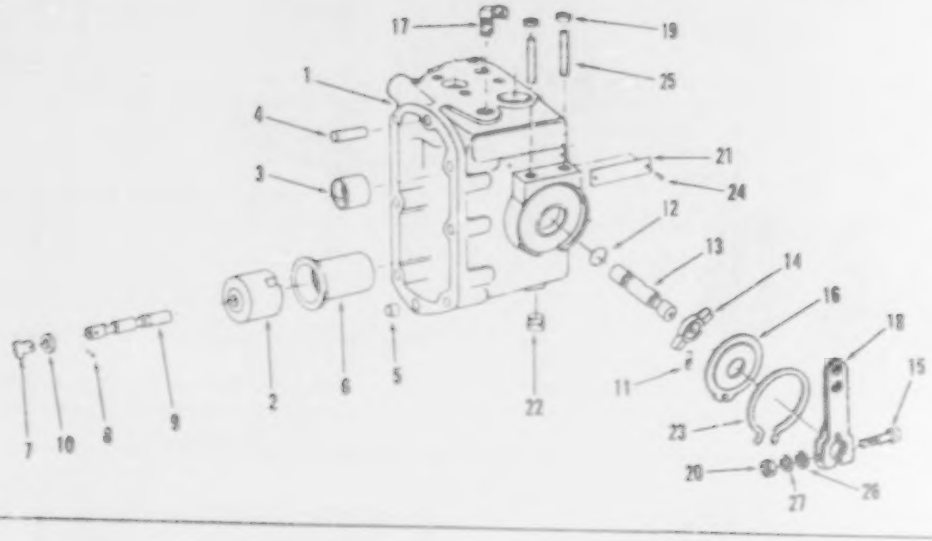
c. Inspect coupling (2) for evidence of excessive wear.

d. Inspect drive shaft (10) for tightness of keys (7, 8) in keyways.

e. Inspect thrust washers (11 and 12) for evidence of wear.

2-406. TESTING. No testing is required.

2-407. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection.



1. Housing
2. Barrel and Sleeve Assembly
3. Tachometer Bushing
4. Dowel
5. Dowel
6. Spring Pack Housing
7. Driver
8. Pin
9. Governor Plunger
10. Thrust Washer
11. Roll Pin
12. Seal
13. Throttle Shaft
14. Throttle Stop
15. Capscrew
16. Cover
17. Elbow
18. Throttle Shaft Lever
19. Throttle Adjusting Nut
20. Nut, Nameplate
21. Nameplate
22. Plug
23. Snap Ring Cover
24. Screw
25. Adjusting Set Screw
26. Lockwasher
27. Washer

Figure 2-71. Housing Assembly

2-408. LUBRICATION. During reassembly, lubricate outside of oil seal, bearings, drive shaft, gears, and couplings with engine oil, Military Specification MIL-L-9000.

2-409. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-410. FUEL FILTER ASSEMBLY.

2-411. *SPECIAL TOOLS.* No special tools required.

2-412. DISASSEMBLY. Disassemble the fuel filter assembly in accordance with figure 2-73.

2-413. CLEANING.

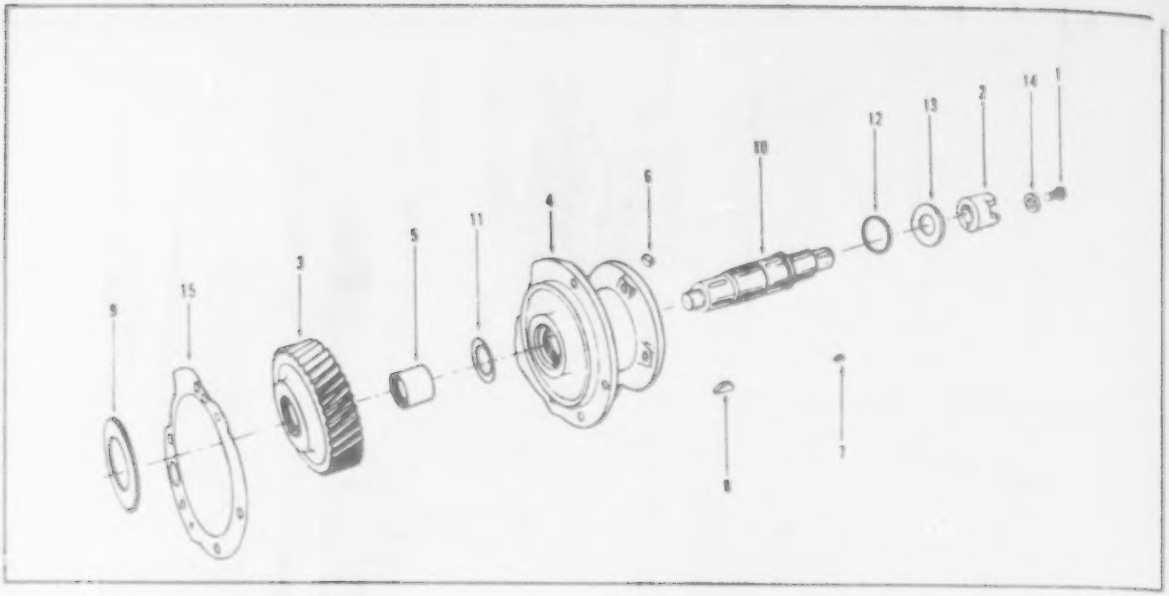
a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

c. Steam clean internal parts with steam jet.

d. Steam clean internal parts with steam jet.

e. Dry with clean, filtered air.



1. Capscrew
2. Coupling
3. Drive Gear
4. Housing
5. Bushing
6. Plug
7. Key
8. Key
9. Slinger
10. Drive Shaft
11. Thrust Washer
12. Thrust Washer
13. Clamp Washer
14. Washer
15. Gasket

Figure 2-72. Fuel Pump Drive Assembly

2-414. INSPECTION.

a. Check threaded parts for stripped threads.

b. Check body components for cracks and leaks.

c. Examine all parts for corrosion and distortion.

2-415. TESTING. No testing is required.

2-416. REPAIR OR REPLACEMENT. Replace all defective parts. Repair slightly worn or damaged threads with a chaser. Replace secondary fuel filter element (13).

2-417. LUBRICATION. No lubrication is required.

2-418. REASSEMBLY. Reassemble in the reverse order of disassembly.

CAUTION

During reassembly of primary filter internal components care must be employed not to over compress the metal disc element stack during replacement of the element retainer cup assembly.

Tighten securely by hand and do not exceed 10 to 15 inch pounds maximum torque.

Failure to abide by above instructions can result in a restricted fuel supply, a lack of engine H.P., and resultant load and frequency response/performance problems.

NOTE

Failure to comply with above cautionary note results in a restricted fuel flow and subsequent reduction in engine power normally reflected by failure of generator set to pull rated KW load. Combined with this situation you may also incur poor frequency response or a steady drop in frequency while unit is under constant load.

NOTE

After installing a new gasket, torque housing retention cap nut to a maximum of 14 foot lbs.

2-419. ENGINE STARTER ASSEMBLY.

2-420. SPECIAL TOOLS. No special tools required.

2-421. DISASSEMBLY. Disassemble starter assembly in accordance with figure 2-74.

2-422. CLEANING.

a. Wash off excess exterior dirt with a soft bristle brush and Chlorothene N.U., Federal Specification O-T-620C.

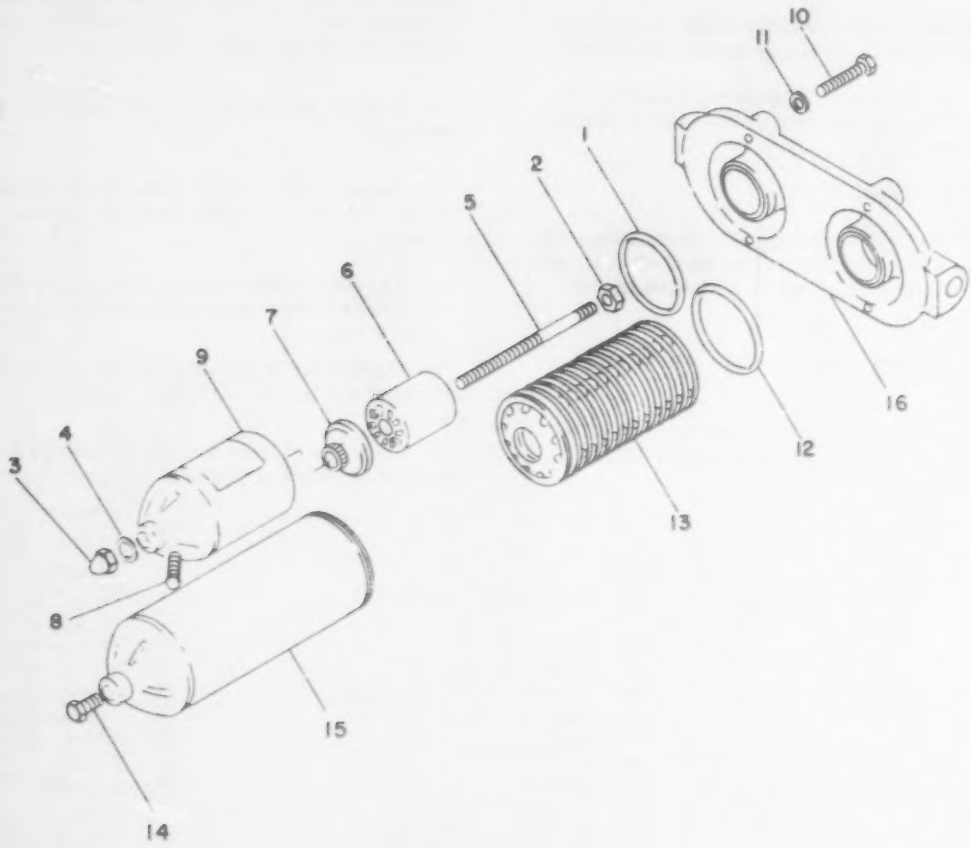
WARNING

When using Chlorothene N.U. Federal Specification O-T-620C, make sure that there is adequate ventilation and that solvent resistant gloves combined with solvent resistant clothing are always worn.

b. Clean commutator with type No. 00 sandpaper.

CAUTION

Do not use emery cloth to clean commutator. Emery may become imbedded in commutator and wear brushes rapidly.



1. Gasket
2. Hex. Plain Nut
3. Cap Plain Nut
4. Gasket
5. Plain Stud
6. Fuel Primary Element
7. Element Retainer
8. Plug
9. Fuel Filter Housing
10. Hex. Hd Cap Screw
11. Gasket
12. Gasket
13. Fuel Secondary Element
14. Plug
15. Fuel Filter Housing
16. Filter Head Assembly

Figure 2-73. Fuel Filter Assembly

c. Blow dust free from windings with filtered, dry, compressed air.

d. Do not soak drive assembly (105) in any type solvent. (Drive unit contains a special lubricant.

e. Clean the insulators, insulating washers, insulated spacers, and brushes (if they are reusable) with a lint free cloth.

2-423. INSPECTION.

a. Inspect the drive housing (94), commutator end housing (54), field ring (82), solenoid shell (31), and bracket (25) for cracks, breaks, damaged threads and other defects.

b. Inspect bushing (109) for score marks and wear patterns.

c. Inspect commutator contact surface (a satisfactory condition is indicated by an even, highly burnished, dark copper color).

d. Inspect the shaft for wear or burrs in the seal area. Replace the shaft if worn or damaged. Examine the insert (112) in the threaded portion of the armature shaft, and replace if damaged or worn beyond usefullness (figure 2-75).

e. Inspect splines of armature shaft for wear and damage.

f. Inspect commutator. Runout should not exceed 0. 003 inch TIR when measured with a dial indicator.

g. Carefully examine arm (104, figure 2-74) for evidence of cracks and metal fatigue at pivot bore.

h. Inspect studs (11) of solenoid assembly for damaged and burned threads.

i. Examine contact housing (8) and shell assembly (31) for evidence of physical damage.

Legend To Figure 2-74

1. Nut
2. Nut
3. Washer
4. Washer
5. Washer
6. Bushing
7. Bushing
8. Housing
9. Plug
10. Jumper
11. Stud Assembly
12. Jumper
13. Gasket
14. Washer
15. Contact Assembly
16. Spring
17. Washer
18. Bushing
19. Washer
20. Armature
21. Roll Pin
22. Spring
23. Washer
24. Roll Pin
25. Bracket
26. Cup
27. Pin
28. Spring
29. Shaft
30. Insulator and Terminal Assy.
31. Shell Assembly
31A. Cushion Coil
32. Coil Assembly
33. Screw
34. Screw
35. Yoke
36. Gasket
37. Spring
38. Sleeve Plunger
39. Plunger and Guide Assy.
40. Plate
41. Seal
42. Screw
43. Bushing
44. Washer
45. Washer
46. Washer
47. Nut
48. Ring
49. Ring
50. Lead Assembly
51. Washer
52. Bushing
53. Ring
54. Housing
55. Bushing
56. Nut
57. Plug
58. Washer
59. Screw
60. Washer
61. Jumper and Screw Assy.
62. Washer
63. Bushing
64. Washer
65. Washer
66. Screw
67. Washer
68. Washer, Thrust
69. Plate
70. Screw
71. Holder Assembly
72. Jumper
73. Brush
74. O Ring
75. Band Assy.
76. Nut
77. Screw
78. Armature Assy.
79. Screw
80. Washer
81. Washer
82. Ring
83. Coil and Jumper Ass
84. Pole Piece
85. Screw
86. Insulator
87. Bushing
88. Ring
89. Insulator
90. Washer
91. Pin
92. Screw
93. O Ring
94. Housing
95. Washer
96. Screw
97. O Ring
98. Shaft
99. Screw
100. Seal
101. Shaft and Insert Assy.
102. Coupling
103. Roll Pin
104. Arm Assembly
105. Drive Assembly
106. O Ring
107. Housing
108. Screw
109. Bushing
110. Wick
111. Bushing
112. Insert

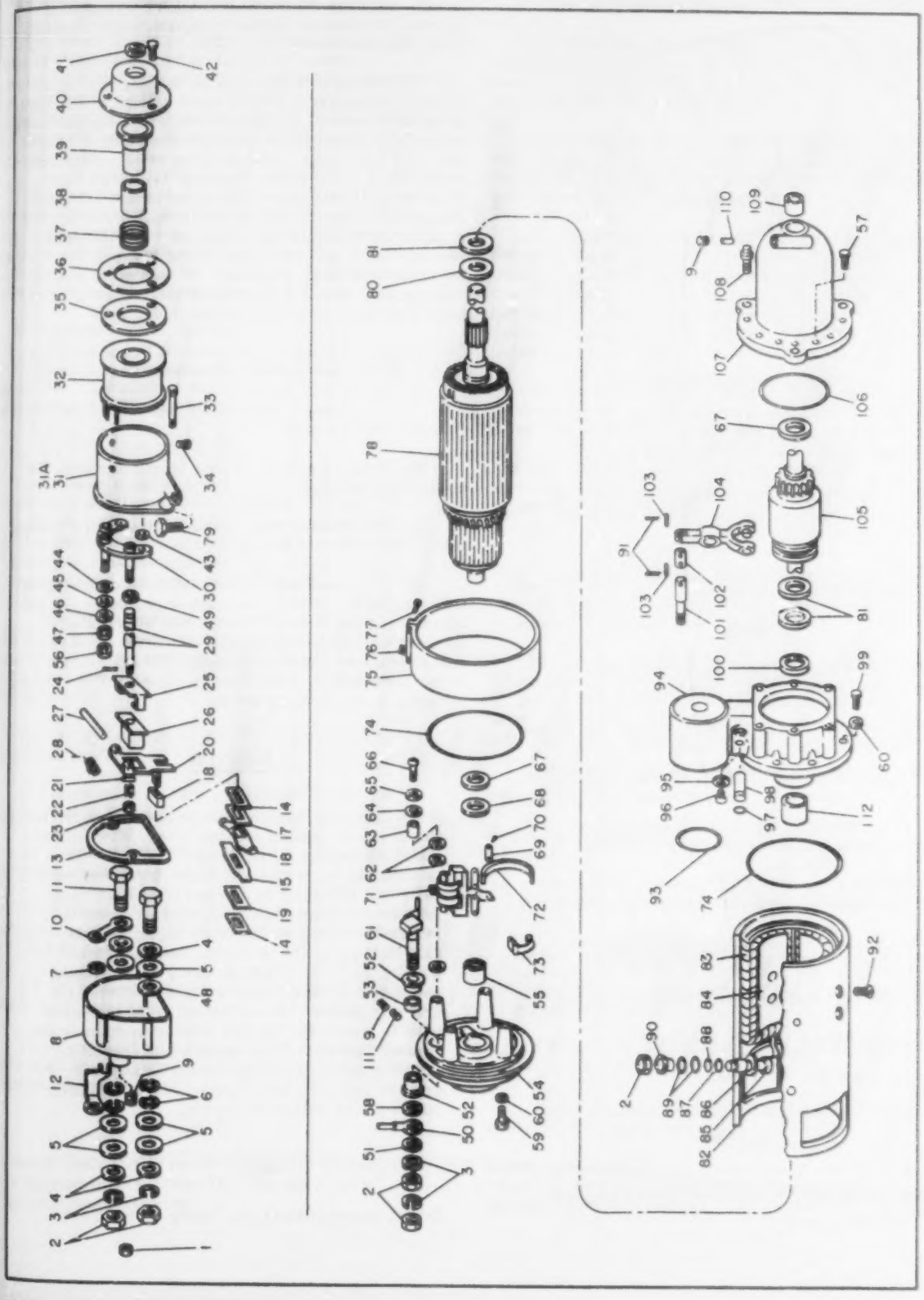


Figure 2-74. Engine Starter Assembly

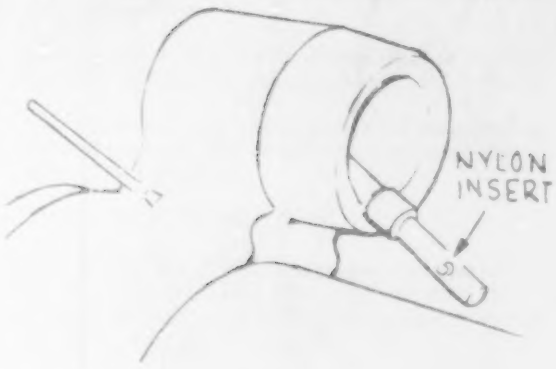


Figure 2-75. Lever and Housing

2-424. TESTING.

a. Use a continuity checker and check for continuity between the commutator and the armature shaft. No continuity should exist.

b. No continuity should exist between the field ring and the field terminal stud.

NOTE

Field coils should be tested only after they have been cleaned and thoroughly dried.

c. Place one test lead on the commutator end housing and check for continuity between each of the four brush holders and the terminal stud. No continuity should exist.

d. Test armature on a growler to determine whether windings and commutator are shorted.

e. If shorted commutator is revealed, turn commutator and recheck the armature with a growler.

f. After reassembly as outlined in preceding paragraph, then apply 24 volts and check for:

1. Clockwise rotation looking at the drive end.

2. Approximately 85 to 90 ampere current draw.

3. Approximately 3800 rpm.

CAUTION

Do not run the starter for more than 3 seconds at a time.

2-425. REPAIR OR REPLACEMENT. Repair or replace the internal starter components per instructions detailed below:

a. GENERAL. If commutator is rough or out of round in excess of 0.003 inch or has high mica, turn commutator down on a lathe, removing only sufficient material to clean up commutator and remove roughness and high mica. Undercut the mica. Minimum remachined commutator diameter is 2.0625 inch. Replace worn brushes. (Minimum length 5/8 inch). Replace grounded or shorted field coil if it cannot be replaced by reinsulating. Replace worn bushings. Replace worn bearings by pressing new bearing bores to 0.750 inch diameter. Finish drive end housing bore to 0.875 inch diameter. Tolerance on bore diameters is plus or minus 0.001 inch.

b. Repair and Special Adjustment Procedures for major starter components are covered as follows:

1. Commutator End Housing (54) Blind Hole Bushing Replacement.

(a) Obtain a 6 inch - 8 inch length of rod 0.750 inches in diameter.

(b) Fill bearing bore approximately three fourths full of heavy wheel bearing grease.

(c) Place rod into bushing bore with housing on a flat surface. With a heavy hammer, drive the rod into the bushing bore. Four or five blows of the hammer will force the bushing out of the housing. Add grease and continue to strike rod until bushing is completely out. Ream new bushing to 0.754 before pressing it into housing bore.

CAUTION

When installing bushing, make sure oil wick slot lines up with drilled passage way. When installating add two or three drops of SAE-30 clean lubricating oil in each oil reservoir. Periodically add at least 3 to 5 drops of SAE-30 clean lubricating oil in each oil reservoir. Annually remove cranking motor from engine and lubricate bushing of the drive and spline. This bushing is in the cranking motor nose housing and it cannot be reached without removing the cranking motor. Clean the spline of the drive with an approved cleaning solvent to remove any gummy deposit. Then apply a thin film of light graphite grease or Molybdenum Disulphide grease, Military Specification MIL-G-21164, so the pinion will move freely.

NOTE

Do not use excessive oil, heavy oil or grease.

2. Pinion Housing.

(a) Minor burrs or damage on the mating surfaces of the pinion housing can be removed or cleaned up with a fine mill file. If the bushing does not meet the allowable wear limits, remove and replace it with a new bushing. Press the new bushing into position and ream to a diameter of 0. 750 plus or minus 0. 001 inch.

(b) Installation of the shift housing bushing is as follows: Reposition the housing with the opposite side up and press the bushing in flush with the housing bore. Drill bushing oil hole using 21/64 inch drill and the oil wick bore as a pilot. Ream to a diameter of 0. 875 plus or minus 0. 001 inch.

3. Internal Switch Timing.

To insure that the switch contacts are properly timed with the switch plunger, check this dimension as illustrated in figure 2-76.

NOTE

The plunger must be in a fully compressed or bottomed position before checking dimension 1. 125 inch as illustrated. (This reading indicates that the plunger, shaft, and contacts are in proper relationship with each other so as to insure proper external switch timing.)

Should the internal timing dimension be other than 1. 125 inch, disassemble switch and replace plunger and shaft assembly. For proper assembly of the shaft and plunger, the following sequence should be followed:

(a) Apply Locktite (Type AA) to the threads to the switch shaft.

(b) Start switch shaft into plunger assembly, approximately 3 turns.

(c) Complete switch assembly making sure that the switch shaft enters rectangular cup.

(d) With a 3/16 inch rod inserted into the switch plunger assembly, depress switch and apply 24 volts to #1 and #4 terminals.

(e) With plunger bottomed (24 volts applied) switch shaft dimension must be 1. 125 inch.

(f) After final adjustment, do not attempt to move shaft for 24 hours to allow curing of the Locktite.

NOTE

Switch shaft should be dimensionally set within approximately Three Minutes after the application of Locktite.

4. Cranking Motor Timing.

(a) After reassembly of the motor, the switch solenoid is installed on the field ring and then the timing is checked for proper travel of the drive pinion on the armature shaft.

(b) The shift lever is inserted through the switch cover seal. Make sure the Nylock insert is in position in the threaded shaft, and that the shaft is aligned with the threaded hole in the plunger.

(c) Insert the switch shaft adjusting tool through the access hole in the end of the switch terminal housing, and turn the shaft clockwise until it bottoms. Back off counter clockwise approximately five turns and push the switch forward into the shaft housing. Align the mounting holes on the switch with the ones in the field ring, and install two mounting screws.

(d) Connect a 24 volt battery to the switch terminals numbers 1 and 2. With the solenoid switch energized check the spacing between the face of the pinion and the thrust washer, using a 0. 187 inch thick gage. The final adjusting tool clockwise or counterclockwise until the 0. 187 inch gage just fits between the pinion and thrust washer.

NOTE

Do not adjust the switch while it is energized, or hold the switch energized longer than 3 seconds. (Figures 2-77 and 2-78.)

(e) With an ohmmeter, or with a light in series with a battery, connect the leads across terminals #2 and #3 (large studs). No continuity should be present with the switch energized and a 0. 812 inch gage inserted. Recheck internal timing of switch.

(f) Replace the pipe plug in the switch terminal housing and seal with Permatex #2 or #3.

2-426. LUBRICATION.

CAUTION

Do not lubricate excessively. Excessive lubricant may cause oil to gum the commutator and reduce the cranking ability of the motor. Never oil the commutator.

a. Lubricate bushings and bearings with light lubricating oil, Military Specification VV-L-820.

b. Apply graphite, Military Specification JAN-G-155 to the shaft of the armature.

2-427. REASSEMBLY. Reassemble starter in the reverse order of disassembly. Pay particular attention to the following:

a. End Housing Assembly to Field Ring.

1. All sealing rings should be lubricated with glycerin prior to installation.

2. Install O-ring (74, figure 2-74) on commulator end housing (54) and secure the housing with four hex head capscrews.

3. Install armature (78) into the field ring (82) at this time, being careful that the steel thrust washer (67) is placed on the shaft first, followed by the fibre washer (68). The fibre washer is designed to ride up against the end housing.

4. Next install the brushes (73) in their respective holders (71) and secure the brush holder jumper (72).

b. Lever and Housing Assembly Procedures.

1. Install the shift lever and linkage assembly into the shift housing. Secure with lever shaft and 10-32 socket head screw and washer. The O-ring on the shaft should be lubricated with glycerin while the shaft uses #5 S. A. E. oil. Refer to figure 2-75.

2. Place the steel thrust washer on the armature shaft, followed by the fibre washer.

3. Slide the shift housing part way onto the armature shaft, and then install the two fibre washers.

4. Place the drive in the housing and index the drive collar into the shift lever.

5. Line up the drive with the armature shaft and slide the entire assembly into place.

6. Install the steel thrust washer, and then the nose housing. Attach the housing with six socket head screws. All the unused screw holes should be plugged with rubber inserts (6 places).

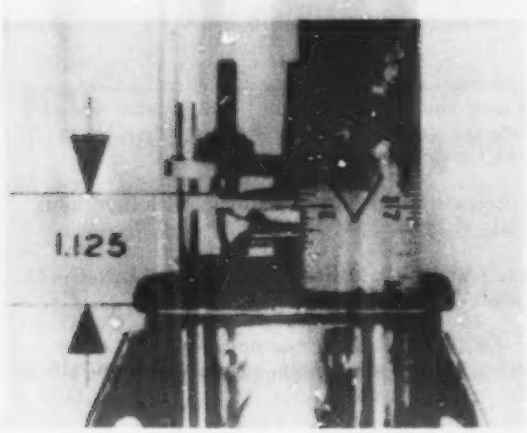


Figure 2-76. Internal Switch Timing

7. Install (99) five socket head screws holding shift housing to field ring. Use Locktite, Type A on threads and torque to 15 ft. lbs.

c. Brush Rigging Assembly.

1. Install oil wick (110) and hex socket plug into housing.

2. Install sealing ring, insulating bushing into e housing and retain with slide jumper screw.

3. Install four brush holders and spring assemblies with accompanying twelve insulating washers and insulating bushings. The insulating washer, double coil lock washer should then be installed at each brush holder support and retained with cross slot round head screws.

NOTE

The brush holder jumper should be installed at the time of brush installation. This is after the armature is in place in the field ring.

d. Brush Opening Cover Bank (75) Assembly.

Coat the steel liner with industrial type rubber cement to hold the inner silicon sponge rubber gask in place. Coat the gasket with Glycerin and install bank assembly on motor so ends of the gasket are over a rib section of the field ring to insure a tight joint.

e. Solenoid Relay Assembly.

1. Install the following parts in sequence on the armature: bushing, insulating washer, guard washe contact spring (concave facing out), contact assembly, insulating washer, guard washer, and retainin pin.

2. Install slide return bracket and cup into arm ture.

3. When installing the contact assembly on the relay, position it so that the support pin holes in th armature are aligned with the pin holes in the rela projections. Insert support pin into one side only. Place armature spring so the center hook is over th edge of the armature and the two straight legs of th spring coils in line with the pin holes, and insert th pin into the retaining support pin holes.

4. Proceed with assembly following previous in structions listed for internal switch timing. Steps through 6.

5. Install a new seal in shaft cover. Install cov with three hex head screws.

6. Reassemble two contact studs (hex) four insulating washers, two flat washers, two lockwashe two hex nuts, and jumper strap onto switch cover. Torque both nuts to 60 - 70 ft. lbs. Install switch cover to switch and install three sealing rings, thre

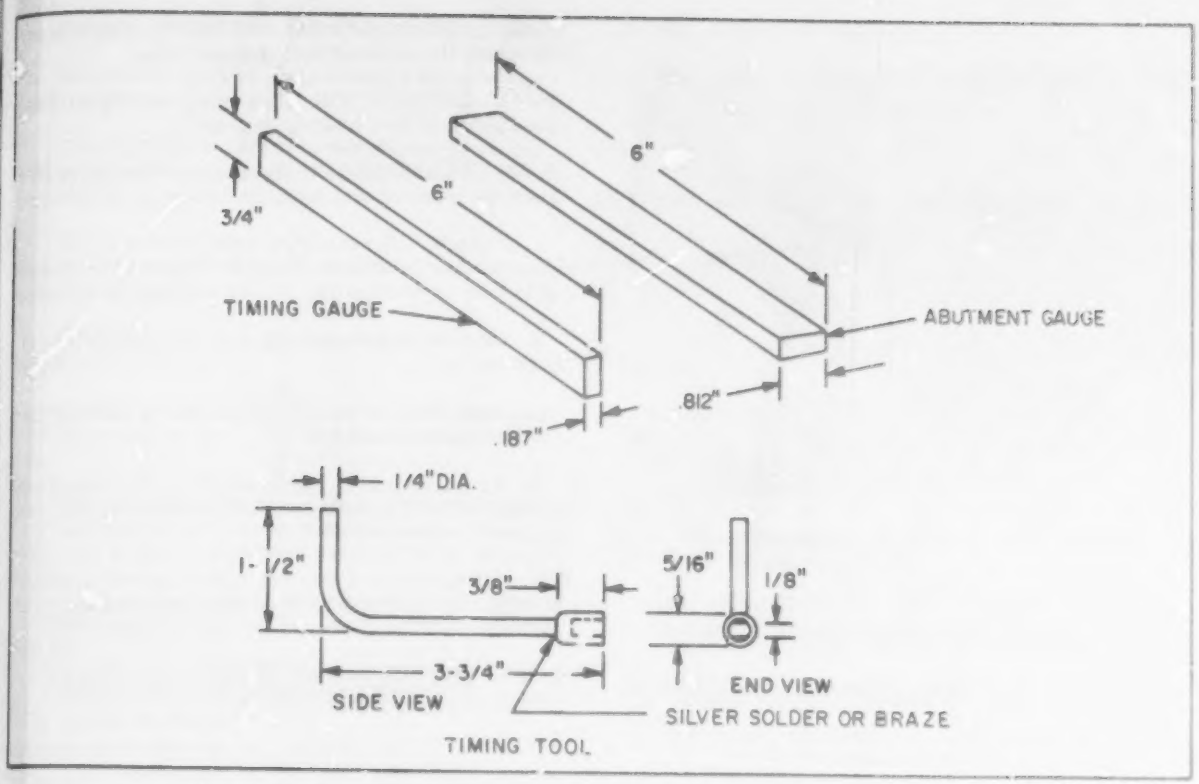


Figure 2-77. Timing Tool and Timing Panel Fabrication Data

insulating washers, three flat washers, three lockwashers, and three nuts on the terminals. Install two sealing nuts to complete switch assembly.

2-428. FUEL INLET AND FUEL OUTLET CONNECTION ASSEMBLY.

2-429. SPECIAL TOOLS. No special tools required.

2-430. DISASSEMBLY. Disassemble both connection assemblies in accordance with figure 2-79.

2-431. CLEANING.

a. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered, compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

c. Dry with clean compressed air.

d. Remove copper gaskets from body ends.

e. Flush filter screen on inlet connection (only) by washing in clean fuel oil and blowing with low pressure, compressed air.

NOTE

If the filter cannot be thoroughly cleaned or is punctured, discard and replace with new one.

2-432. INSPECTION. Inspect both fuel connections in following manner:

a. Check spring for excessive length.

b. Check fuel connections and body for cracks and leaks.

c. Check inlet connector screen for damage. Replace if punctured.

d. Inspect body mounting threads for worn and cross threads.

2-433. TESTING. No testing required.

2-434. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection.

2-435. LUBRICATION. No lubrication required.

2-436. REASSEMBLY. Reassemble in the reverse order of disassembly.

Figure 2-78. Timing Gauge Installation

2-437. LUBRICATING OIL COOLER ASSEMBLY.

2-438. SPECIAL TOOLS. No special tools required.

2-439. DISASSEMBLY. Disassemble lubricating oil cooler in accordance with figure 2-80.

2-440. CLEANING. Clean exterior of cooler by steam cleaning then flush complete unit including element oil cooler (tube bundle) with an approved dry cleaning solvent. Wipe clean with a lint free cloth. Dry with clean, filtered, compressed air.

2-441. INSPECTION.

a. Inspect tube bundle (core) for corrosion and cracks where tubes are welded to end plates.

b. Inspect lubricating oil cooler assemblies for leakage between oil and water passages.

c. Examine complete cooler for cracks and defective mounting flange.

2-442. TESTING.

a. Clamp housing and cooler assembly in fixture and attach air connection.

b. Place complete unit in water tank and apply 1 to 4 psi air pressure to water side.

c. Inspect for air leaks, porosity in casting, and leaking packing rings.

d. Apply line air pressure of 35 to 40 psi to oil side.

e. Repeat inspection procedure of c above.

2-443. REPAIR OR REPLACEMENT. Replace any defective items noted during inspection.

2-444. LUBRICATION. Lubricate packing with a good grade of ball bearing grease.

2-445. REASSEMBLY. Reassemble oil cooler in reverse order of disassembly. Note the following:

a. Always lubricate rubber O-ring used in groove at bottom of housing just prior to installing element.

b. Ensure ring does not get twisted and is free of cuts and nicks.

c. Push element into housing aligning index marks on housing and element.

d. Press second O-ring around top of element with a wooden block to endure equal pressure around ring circumference.

e. Always place a new retainer ring over rubber O-ring, and assemble new gasket and front cover to housing.

2-446. ROCKER LEVER HOUSING AND COVER HOUSING ASSEMBLY.

2-447. SPECIAL TOOLS. No special tools required.

2-448. DISASSEMBLY. Disassemble rocker lever housing and cover housing in accordance with figure 2-81. Pay particular attention to these special items:

a. Remove cap (7) and screw securing lever shaft (13) in rocker housing (27).

b. Remove setscrew positioning rocker lever shaft in housing.

c. Drive a pointed punch through the expansion plug (12).

d. Using a flat or drift punch, remove shaft (13).

e. Place lever shaft in a V block. Insert a pin in the locking screw hole and remove other expansion plug (12) from housing (27).

f. Press out bushing (17, 22, and 26) with a mandrel and block.

2-449. CLEANING. Clean the components of this assembly by washing in dry cleaning solvent Federal Specification P-S-661. Wipe with a lint free cloth and dry with filtered low pressure compressed air.

2-450. INSPECTION. Inspect the various components of the rocker lever housing in the following manner:

a. Visually inspect all capscrew holes for damaged threads.

b. Visually inspect for cracks, chips, or breaks.

c. Inspect entrance of shaft bore for sharp edges, nicks, or burrs.

d. Check breather vent hole and rocker lever oil drilling to make sure they are free of dirt and other deposits.

e. Check rocker lever shaft bore ID. Refer to table 2-4 for wear limits. If shaft bore is not within tolerance discard housing.

f. Check rocker lever for surface imperfections by magnetic inspection.

g. Check ball end of rocker lever adjusting screw, must be a true sphere. Check with 1/4 inch radius gage.

h. Check thread condition on all screws and levers. Examine closely for thread distortion at assembly portion of locknut. Screws must run freely through levers.

i. Examine injector rocker lever sockets for a true fit.

j. Check intake and exhaust rocker lever to crosshead contact surfaces.

k. Check rocker lever shaft for wear and scoring.

2-451. TESTING. No testing required.

2-452. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection and repair following components.

a. Repair slightly worn threads with a chaser of the correct size.

b. Replace bushings if they exceed tolerance listed in table 2-4.

c. Regrind intake and exhaust rocker lever to crosshead contact surfaces to original contour, if required.

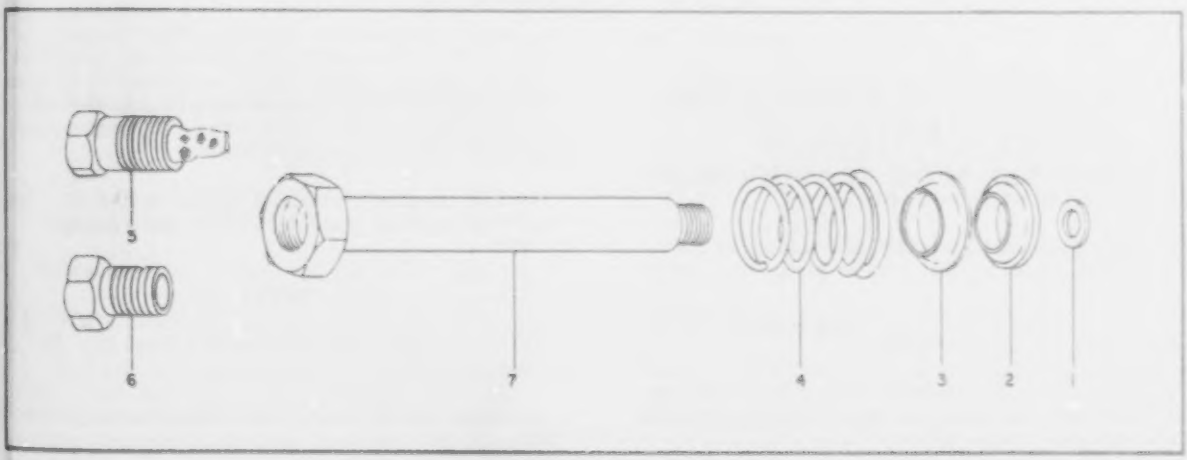
d. Remove sharp edges of shaft bore by using 240 grit aluminum oxide paper over a split rod, rotating in an electric drill.

2-453. LUBRICATION. Apply a light coat of engine oil, Military Specification MIL-L-9000 to mating surfaces during reassembly.

2-454. REASSEMBLY. Reassemble in the reverse order of disassembly. Note the following.

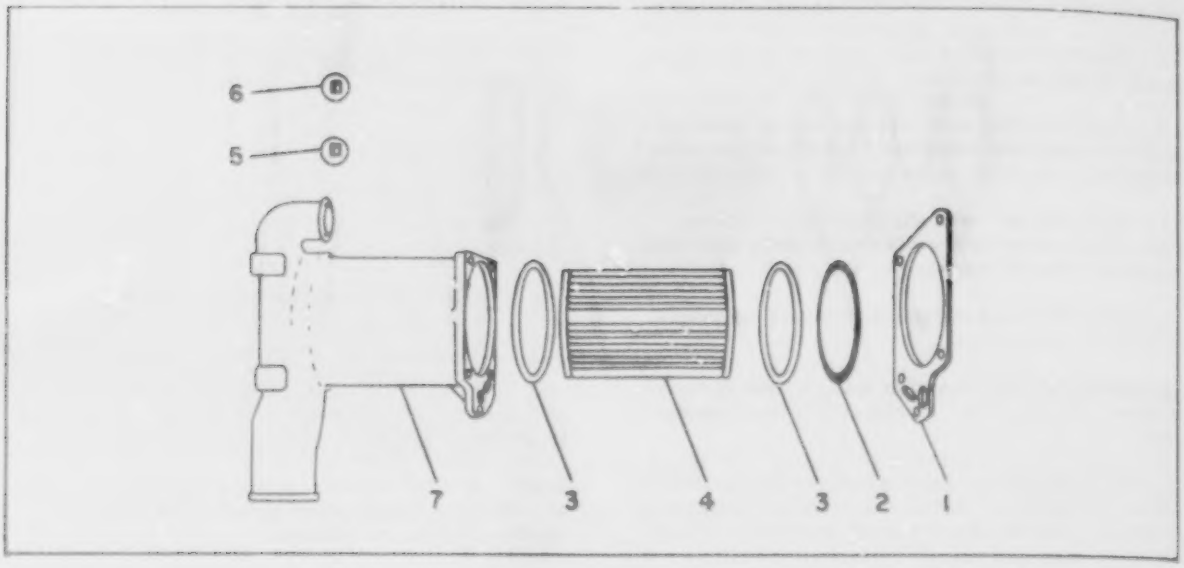
a. Install adjusting screws and locknuts in rocker levers.

b. Install cup type plug in rocker lever shaft or, if threaded plug is used, tighten to 20 - 25 ft. lbs.



1. Gasket
2. Gasket
3. Gasket Retainer
4. Spring
5. Fuel Inlet Connection
6. Fuel Drain Connection
7. Body

Figure 2-79. Fuel Inlet and Outlet Connections



1. Gasket
2. Element Retainer
3. Packing
4. Oil Cooler Element
5. Plug
6. Plug
7. Housing

Figure 2-80. Lubricating Oil Cooler

c. Coat rocker lever shaft with clean lubricating oil.

d. Start shaft into housing. Install levers on shaft as shaft is pushed through housing.

e. Install exhaust, injector, and intake levers; then intake, injector, and exhaust levers.

f. Check all levers for freedom of movement on shaft to prevent future galling.

g. Coat old style expansion (cup) plug contact surface with Locktite sealer or equivalent. Install with expansion plug with a driving tool.

NOTE

If distance from end of shaft to end of housing is less than 0.275 inch, use end of tool stamped STD. If distance is more than 0.275 inch, press plug will interfere with shaft and will not seal. Install and tighten shaft setscrew.

2-455. FUEL INJECTOR ASSEMBLY.

2-456. SPECIAL TOOLS. No special tools required.

2-457. DISASSEMBLY. Disassemble injector assembly in accordance with figure 2-82. Pay particular attention to the following.

a. Lift out injector plunger (6) and spring (8). Remove spring from plunger and then place plunger in body.

NOTE

Injector bodies and plungers are class fit. Do not interchange.

b. Place injector in proper holding fixture so the fixture spring tension is against injector plunger. Use spacers to obtain required spring tension.

NOTE

Do not remove adjustable orifice plug inlet drilling.

c. Remove injector cup with a six spline type cup wrench.

2-458. CLEANING. Clean various components of fuel injector assembly in following manner:

a. Thoroughly soak and clean injector in solvent such as Bendix Metal Cleaner, Kelite Formula 1006, or an M. S. equivalent.

b. Neutralize solvent after cleaning by dipping parts in mineral spirits.

c. Dry with filtered, dry, compressed air.

CAUTION

Never use drills or other unauthorized instruments to clean cup holes that will alter size of holes. Wires may be used with a pin vise if a smaller size wire is used, then the spray hole.

d. A clean shop, clean tools and good cleaning practices are essential to good injector overhaul. (Most injector failures occur because of dirt).

2-459. INSPECTION.

a. Inspect spray holes and tip with magnifying glass. Compare with cup shown in figure 2-83.

b. Corrosion damage and effect of excessive heat. This condition usually results from high acid or sulphur content in fuel or overload operating conditions. See figure 2-84.

c. Enlarged or distorted spray holes, caused by cleaning with drills or other unauthorized instruments.

d. Inspect cup for plunger seat pattern. If plunger seat covers 40 percent continuous area around cup, cone or plunger bore, it is possible cup may be reused, but it must pass cup to plunger specialized leakage test.

CAUTION

Never alter size of injector cup spray holes.

e. Inspect body plunger bore for scoring.

f. Use strong magnifying glass to check for burrs, carbon, and distorted radii in orifices and check ball gasket seat. (When injector orifices or gasket seats are damaged, the injector will not function properly).

g. For mutilation check in area (black area) as shown in figure 2-85.

h. Check surface flatness with blue layout dye on a lapping plate. If uneven or mutilated discard.

i. Check inlet and drain connection holes for damaged threads or copper gasket surfaces.

j. Inspect plunger closely for metal seizure.

k. Bright spots or surface disruption at top of plunger on opposite side at bottom of plunger or at midpoint, usually are normal results of rocker lever thrust action. Unless metal is displaced or wear measurable at these points plunger may be reused.

l. Narrow streaks running the length of the plunger usually are the result of the varying thickness of pentrate treatment used to prevent rusting and the plunger is satisfactory for reuse.

m. Check spring for excessive wear or mutilation.

n. Test spring tension.

o. If injector spring compress to dimensions shown in table 2-7 at less than load indicated under worn limits springs must be discarded.

2-460. TESTING. Test injector on a master calibration per 1000 strokes at 120 psi with an 3 spray hole cup. Hole size 0.007 x 17 degree angle.

2-461. REPAIR OR REPLACEMENT. Replace any item noted defective or out of tolerance during the inspection. Repair various fuel injector components as follows: Plunger link (4) both E ring type and sleeve type can be removed and replaced.

CAUTION

Handle injector plunger with care to prevent damage which would render it useless.

a. Remove link by pulling out with a collet type hand tap holder.

b. Hold plunger and give tap handle a quick pull.

NOTE

Do not place plunger in vise to pull link injector body.

c. Rechase inlet and drain connection threads with a 1/2 - 20 tap.

d. Thoroughly clean body after repair.

2-462. LUBRICATION. No lubrication required.

2-463. REASSEMBLY. Reassemble fuel injector in the reverse order of disassembly. Note the following.

a. Install new O-ring packing (1) with proper assembly tool part number.

1. Dip O-ring in clean lubricating oil.

2. Assemble proper tool over threaded end of injector body.

b. Select new injector cup gasket corresponding to plunger body size. See figure 2-86 for location size markings on plunger and figure 2-87 for body markings.

c. Install proper cup on injector body finger tight. Back up up one half turn.

d. Immerse injector plunger in clean injector test oil and install in body without spring and place injector in holding tool and with correct spacer to align plunger in body. Tighten cup to specified torque of 55 ft. - lbs. with applicable cup wrench.

e. Remove injector plunger from body. Lubricate plunger with test oil. Install injector spring and plunger in correct body. Check to see that it does not bind as it seats in cup.

f. Check spray pattern.

2-464. FLYWHEEL AND COVER ASSEMBLY.

2-465. SPECIAL TOOLS. No special tools required.

2-466. DISASSEMBLY. Disassemble flywheel and cover assembly in accordance with figure 2-88.

2-467. CLEANING. Clean both these assemblies by washing with an approved dry cleaning solvent, Federal Specification P-S-661. Then steam clean to remove all excess grease, oil and dirt. Clean all mating surfaces free of gasket materials. Wire brush any areas where rust is apparent. Wipe clean with lint free cloth. Dry both components with filtered, compressed air.

2-468. INSPECTION. Inspect flywheel ring gear for broken and cracked teeth. Examine flywheel cover housing for oversize mounting holes and casting cracks. Use dye penetrant or Magnaflux inspection methods.

2-469. TESTING. No testing required.

2-470. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Repair flywheel as detailed below:

a. If it is necessary to replace the ring gear, remove by driving gear from flywheel with a blunt chisel.

b. Heat new ring gear in an oven.

NOTE

If an oven is not available, heat gear with a heating torch - not a cutting torch from inside diameter so heat travels outwards toward teeth.

c. Use a tempstick crayon or equivalent to determine amount of heat applied. Stroke gear with 600 degree F crayon several times while applying heat. This crayon will leave a chalk mark until temperature reaches 600 degrees F. At 600 degrees F the crayon will leave a liquid smear.

CAUTION

Overheating to temperatures above 660 degrees F will soften gear.

d. Place ring gear on flywheel and quickly drive onto flywheel until gear is firmly seated.

e. Allow to cool by natural means. Do not accelerate by using ice or other means of rapid cooling.

CAUTION

Do not attempt to remachine flywheels in shop that is not equipped to maintain factory standards both on dimensions and static balance. The static balance tolerance of flywheel is 2 inch 0. 020 Maximum.

2-471. LUBRICATION. No lubrication required.

2-472. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-473. CYLINDER HEAD ASSEMBLY.

2-473A. SPECIAL TOOLS. No special tools required.

Legend To Figure 2-81

1. Cover Gasket
2. Cover
3. Cover
4. Screw
5. Lockwasher
6. Washer
7. Cap
8. Gasket
9. Vent Plug
10. Lockplate
11. Screw
12. Plug
13. Rocker Shaft
14. Nut
15. Screw
16. Lever and Bushing Assembly
17. Bushing
18. Nut
19. Screw
20. Lever Assembly
21. Socket
22. Bushing
23. Nut
24. Screw
25. Lever and Bushing Assembly
26. Bushing
27. Housing
28. Gasket

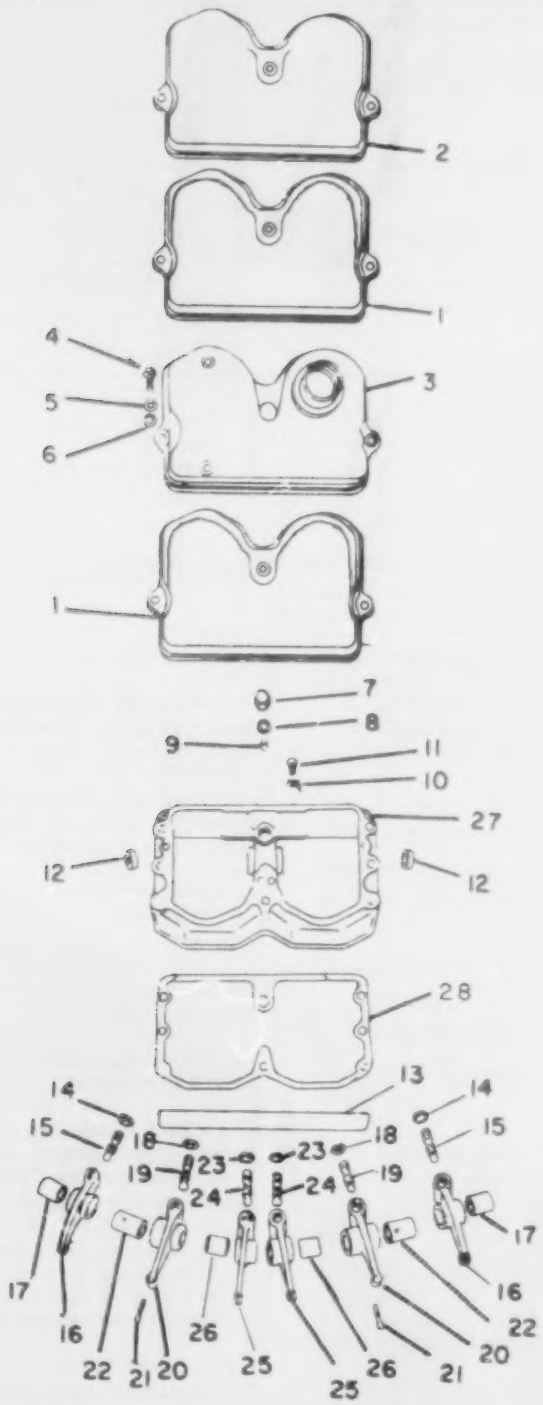
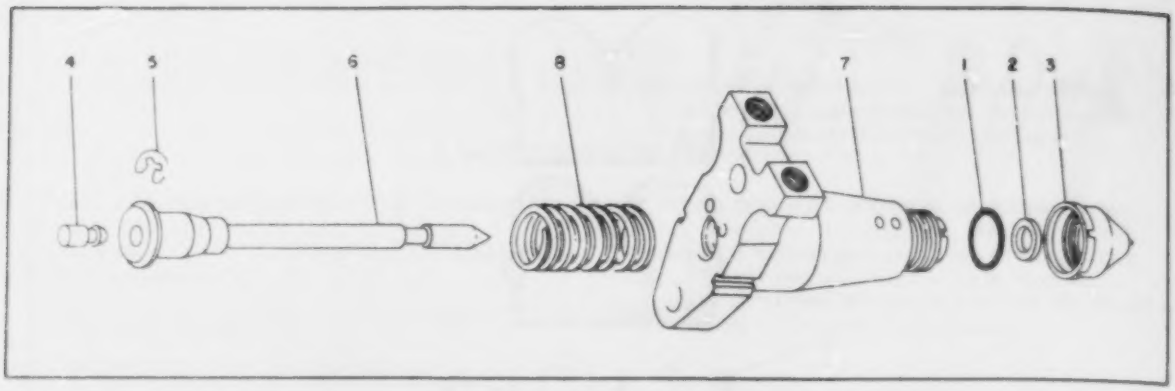


Figure 2-81. Rocker Lever and Cover Housing Assembly



1. Packing Preformed
2. Gasket
3. Cup
4. Plunger Link
5. Clip, Retaining
6. Plunger Rod
7. Injector Housing
8. Spring

Figure 2-82. Fuel Injector Assembly

2-474. DISASSEMBLY. Disassemble cylinder head in accordance with figure 2-89. Pay particular attention to the following specialized procedures applicable to various subassembly components that constitute the complete cylinder head assembly.

a. Cylinder Head.

1. Remove pipe plugs from fuel connector holes at top rear of number 3 cylinder head and top front on number 1 cylinder head.

2. Remove valves, valve springs, retainers, and guides.

3. Remove all pipe plugs from fuel passages in each end of cylinder head.

b. Sleeve Removal.

Remove worn sleeves with a muffler sleeve cutting tool if extreme caution is observed.

c. Valve Seat Insert.

Remove loose or excessively worn valve seat inserts with an insert extracting tool or by striking insert sharply with a chisel, causing it to crack and release press fit. Remove all inserts if head has been resurfaced.

d. Valve Cross Head Guides.

Remove crosshead guides with the approved puller which contains different size collets for various type guides, both solid and tubular type.

2-475. CLEANING.

a. Wash all parts in an approved cleaning solvent equal to Federal Specification P-S-661. Dry with clean, filtered, compressed air.

b. Submerge the raw cylinder head in Wyandotte G solvent or equivalent heated to near boiling temperature. Follow manufacturer's recommendations as to use.

c. Circulate solvent to increase effectiveness on salt, lime deposits, grease etc.

d. Clean valves, valve springs and collets by submerging in solvent.

e. Clean lubricating oil passage figure 2-90 to be sure it is open.

f. After drying with compressed air, using orbital sander, sand cylinder head surface lightly just enough to shine and finish. This permits a more complete inspection of mating surfaces.

NOTE

Do not use a disc sander. Serious damage could result to the sealing surface of the head.

2-476. INSPECTION. Inspect the cylinder head and its components in the following manner:

a. Cylinder Head.

1. Visually inspect for cracks or broken casting areas.

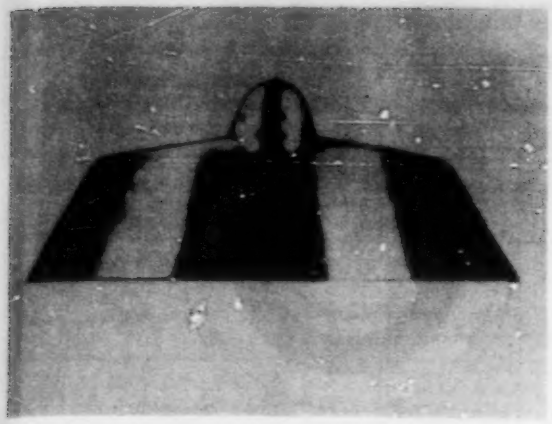


Figure 2-83. New Injector Cup

2. Inspect valve and injector port areas using a portable magnetic crack detector.

b. Crosshead Guides.

1. Check guide outside diameter with micrometers. See table 2-4 for wear limits

2. Check guide for straightness. It should be at right angles to milled surface of head.

c. Cylinder Head Fuse Plug.

1. Examine fuse plug for evidence of overheating. See figure 2-91.

2. If fuse plug has melted check carefully for further damage to head or engine block.

d. Valve Seats.

1. Check for loose valve seat inserts by lightly tapping head near inserts.

2. If valve seat insert is loose enough to bounce or cannot be reground, mark for replacement.

3. If seat area width (1 or 2 figure 2-92) exceeds 0.125 inch at any point and cannot be narrowed sufficiently it is unlikely that seat can be successfully reground.

e. Injector Sleeves.

1. Visually examine for scratches on cup seat area.

2. Lightly coat a new injector cup (on injector body) with Prussian Blue. Install in injector sleeve and torque injector into sleeve evenly to operating tension. Remove and check seat pattern blueing bond must be 0.060 inch width and located approximately 15/32 inches from bottom of head surface.

If indicated seat width does not meet the above specifications, mark sleeve for replacement.

3. Check injector seat depth by installing an injector assembly. Torque nylon locking capscrew to 1/2-14 ft. lb.

4. If nylon locking capscrew is not used, torque capscrews to 10/12 ft. lb.

5. Measure tip protrusion with dial indicator injector cup tips should protrude 0.040/0.055 inch beyond cylinder head milled surface. Maximum allowable protrusion is 0.065 inch.

f. Crossheads.

1. Check for cracks with Magnaflux process.

2. Check wear limit against specifications in table 2-4.

g. Valves, Guides and Springs.

1. Check valves for heads that are cupped, cracked, pitted, or worn too thin to grind. Refer to table 2-4 for wear limits.

2. Check valve head rim thickness. It should be a minimum of 1/16 inch.

3. Stems for scores or worn beyond limits. New dimensions are 0.4500 - 0.4510 inch.

4. Collet recesses worn so as to prevent a new collet fitting securely.

5. Check valve guide ID with a bore gage, Starret No. 829D or equivalent.

NOTE

A plug gage is not suitable as it will not detect an out-of-round hole.

6. Check readings against wear limits in table 2-4.

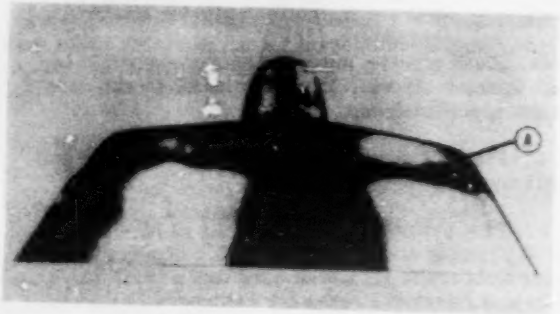


Figure 2-84. Corroded Injector Cup

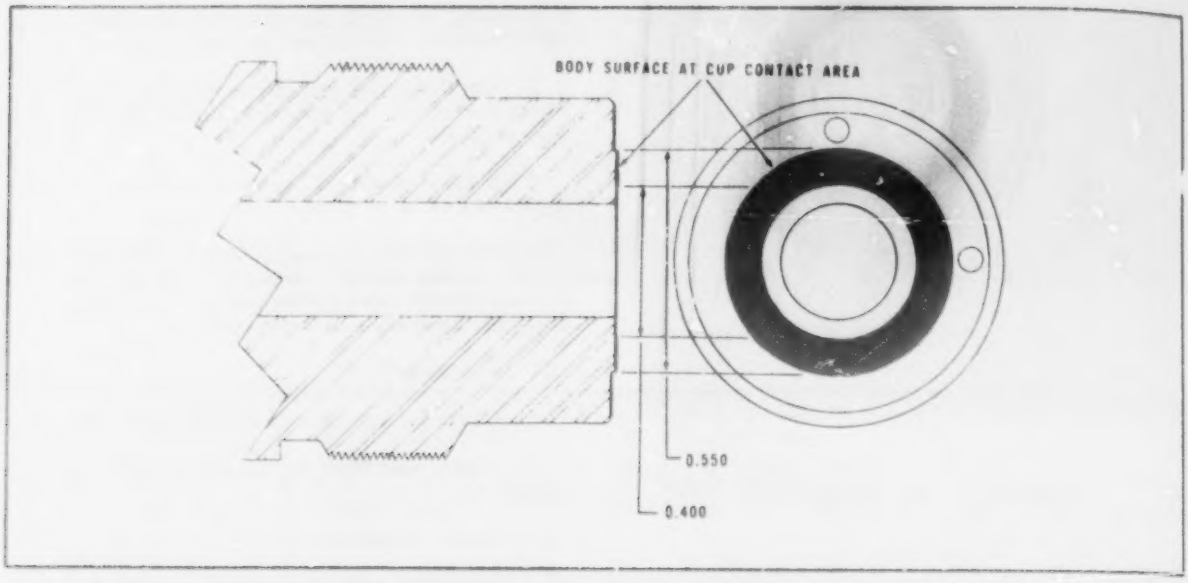


Figure 2-85. Body Surface at Cup Contact Area

7. Check valve guide protrusion. New minimum 1.315 inch and new maximum 1.325 inch.

8. Inspect valve springs for breakage.

9. Test valve spring on spring tester capable of very accurate measurements of spring lengths. Refer to table 2-8.

2-477. TESTING. Test cylinder head and its components in the following manner:

a. Cylinder headless valves, springs, and crossheads, water test in sequence described.

1. Replace all pipe plugs if not in place. Use Teflon sealing tape or liquid lead sealer to prevent leakage. Torque plugs to values listed in table 2-5.

2. Install fuel inlet and drain fittings in same position as removed from each cylinder head.

3. Place a scrap injector and cup assembly in each injector sleeve. Tighten injector to standard torque specifications.

4. Place cylinder head in water test fixture and apply water.

5. Test cylinder heads for leaks at 35 - 85 psi and if possible at 175 degrees to 200 degrees F water temperature. Check carefully around valve seats and injector sleeves for evidence of cracks, even though such cracks might not show water leakage. This type crack is caused when injector capscrews are tightened beyond factory torque specifications.

6. Discard head if cracked.

7. Open water outlet valve on test fixture and observe for free circulation of water through cylinder head. If restriction is evident, remove plugs and clean water jacket of salts, lime and sludge.

b. Valve Seats. Valve seating may be tested with a vacuum tester.

CAUTION

Never vacuum test cylinder heads with injectors installed.

c. Vent Holes. Test each cylinder to ensure that the unit hole is open.

2-478. REPAIR OR REPLACEMENT. Replace any item noted defective during inspection or out of tolerance according to wear limits table 2-5. Repair cylinder head and associated components as detailed below.

a. Resurface cylinder head. Remove 0.005 to 0.006 inch material at one time and no more than worn limit of 4.340 inch minimum 4.370 inch maximum 4.380 inch.

b. Regroove cylinder head for engines using beaded cylinder liners and steel head gaskets. Regroove with cylinder head grooving tool.

c. Machine bead with standard tool.

Table 2-7. Injector Spring Data

Part No.	Approximate Free Length Inches	No. Coils	Wire Dia. Inches	Pounds Load Required to Compress Springs to Length			
				Inch Length	New Min.	New Max.	Worn Limit
62/23	2-1/32	7	0.1875	1-9/16	135	149	130

Table 2-8. Valve Spring Test Data

Valve Spring Part Number	Approximate Free Length In. [mm]	No. Coils	Assembled Height In. [mm]	Wire Diameter In. [mm]	Length In. [mm]	Required Load For Length		
						Lb [kg] New Minimum	Lb [kg] New Maximum	Lb [kg] Worn Limit
111446	3.160 [80.2640]	11.5	2.250 [57.1500]	0.148 [3.7592]	1.765 [44.8310]	104 [47.1744]	114 [51.7104]	100 [45.3600]

d. Counterbore valve 0.006 to 0.0010 inch deeper than insert thickness to permit peening of head to hold insert.

CAUTION

Overswaging around insert may crack cylinder head.

e. Grind valve seats with standard tool and seating stones.

f. Ream cylinder heat capscrew holes for the full length to a diameter of 0.750 inch. This procedure normally removes interference and reduces possibility of capscrew failures.

2-479. LUBRICATION. No lubrication required.

2-480. REASSEMBLY. Reassemble the cylinder head and its components in the reverse order of disassembly.

2-481. OIL PAN AND GAGE ASSEMBLY.

2-482. SPECIAL TOOLS. No special tools required.

2-483. DISASSEMBLY. Disassemble oil pan in accordance with figure 2-93.

2-484. CLEANING.

a. Flush out complete oil pan with an approved cleaning solvent, Federal Specification P-S-661.

b. Steam clean parts with steam jet, then dry with low pressure, compressed air.

c. Be sure to clean all gasket material from mounting flanges.

2-485. INSPECTION.

a. Visually check oil pan (18) for cracks.

b. If a leak is suspected, check area with dye penetrant.

c. Allow penetrant to dry for fifteen minutes. Do not force dry.

d. Spray area with dye developer and check for indication of crack.

e. Check all threaded holes for damaged threads. Pay particular attention to oil drain connection adapter fitting.

2-486. TESTING. No testing required.

2-487. REPAIR OR REPLACEMENT. Replace any item noted defective during inspection. Minor cracks can be repaired by welding.

CAUTION

Perform no welding on mating surfaces of oil pan.

2-488. LUBRICATION. No lubrication required.

2-489. REASSEMBLY. Reassemble in reverse order of disassembly.

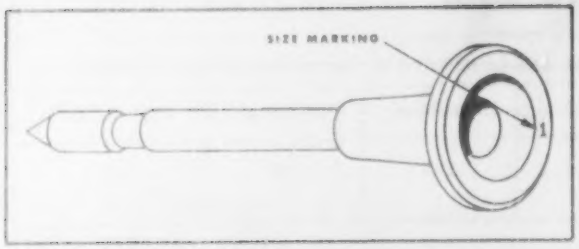


Figure 2-86. Size Marking Location On Plunger

2-490. CAM FOLLOWER HOUSING ASSEMBLY.

2-491. SPECIAL TOOLS. No special tools required.

2-492. DISASSEMBLY. Disassemble cam follower housing in accordance with figure 2-94. Pay particular attention to the following:

a. Remove lock screws holding shafts (4) in housing.

b. Remove cup plugs by using sharp pointed driver and punching a hole in center of plug. Tip one side of plug to force other side of plug out of hole. Remove with pliers.

c. Using proper mandrel press both shafts out opposite end forcing cup plug out of hole.

d. Remove cam follower levers from housings.

2-493. CLEANING. Clean cam followers and push tube in solution of mineral spirits and blow out with dry, filtered, compressed air. Clean remainder of metal components with dry cleaning solvent, Federal Specification P-S-661. Dry with a lint free cloth.

2-494. INSPECTION.

a. Inspect all parts for corrosion, damage and other defects.

b. Magnaflux lever assemblies in accordance with Military Specification MIL-M-11472.

c. Using a micrometer, check the diameter of roller pins. Measurement should not be less than that specified in table 2-4.

d. Using an inside micrometer, inspect cam follower lever bushing. Measurement should not be less than that specified in table 2-4.

e. Using a micrometer, check diameter of lubricating rod shafts. Measurement should not be less than that specified in table 2-4.

f. Using a dial indicator depth gage, check parallelism of lubricating rods with respect to milled surface of cam housing when assembled. Variation should not exceed 0.015 inch.

g. Using a radius gage, check the push rod ball joint. Measurement should not be less than that specified in table 2-4.

h. Check push tubes to see whether they are bent (out of round). Maximum allowable tolerance not to exceed 0.025 inch out of round.

2-495. TESTING. No testing required.

2-496. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Repair various components as follows:

a. Minor scratches may be removed using crocus cloth, Federal Specification P-C-458.

b. If lever bushings are faulty, press new bushings into lever assemblies with a mandrel and block. Be sure oil passages line up correctly.

c. Fill oil passage holes in lever bushings with soft soap.

d. Using a slow speed drill press and a 60 degree angle cutter, chamfer each end of lever bushing.

e. Bore lever bushings to 0.7495 to 0.7505 inch. Check the bored bushing with a plug gage.

f. Remove soap from oil passages with clean, filtered, compressed air.

2-497. LUBRICATION. No lubrication required.

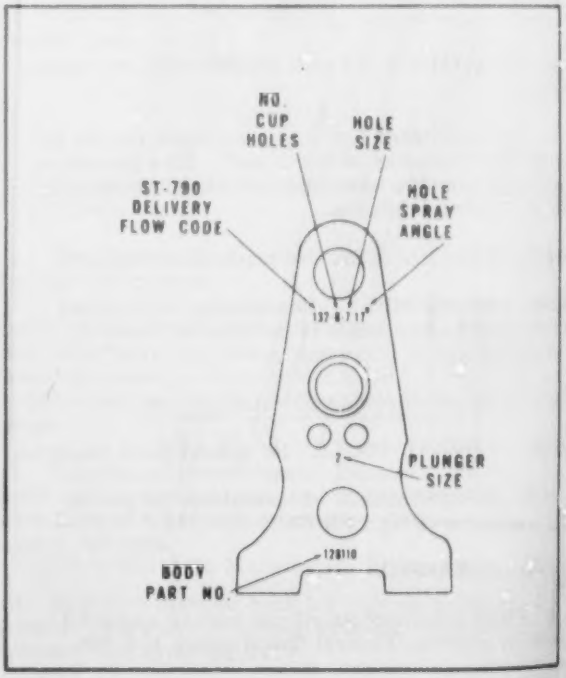
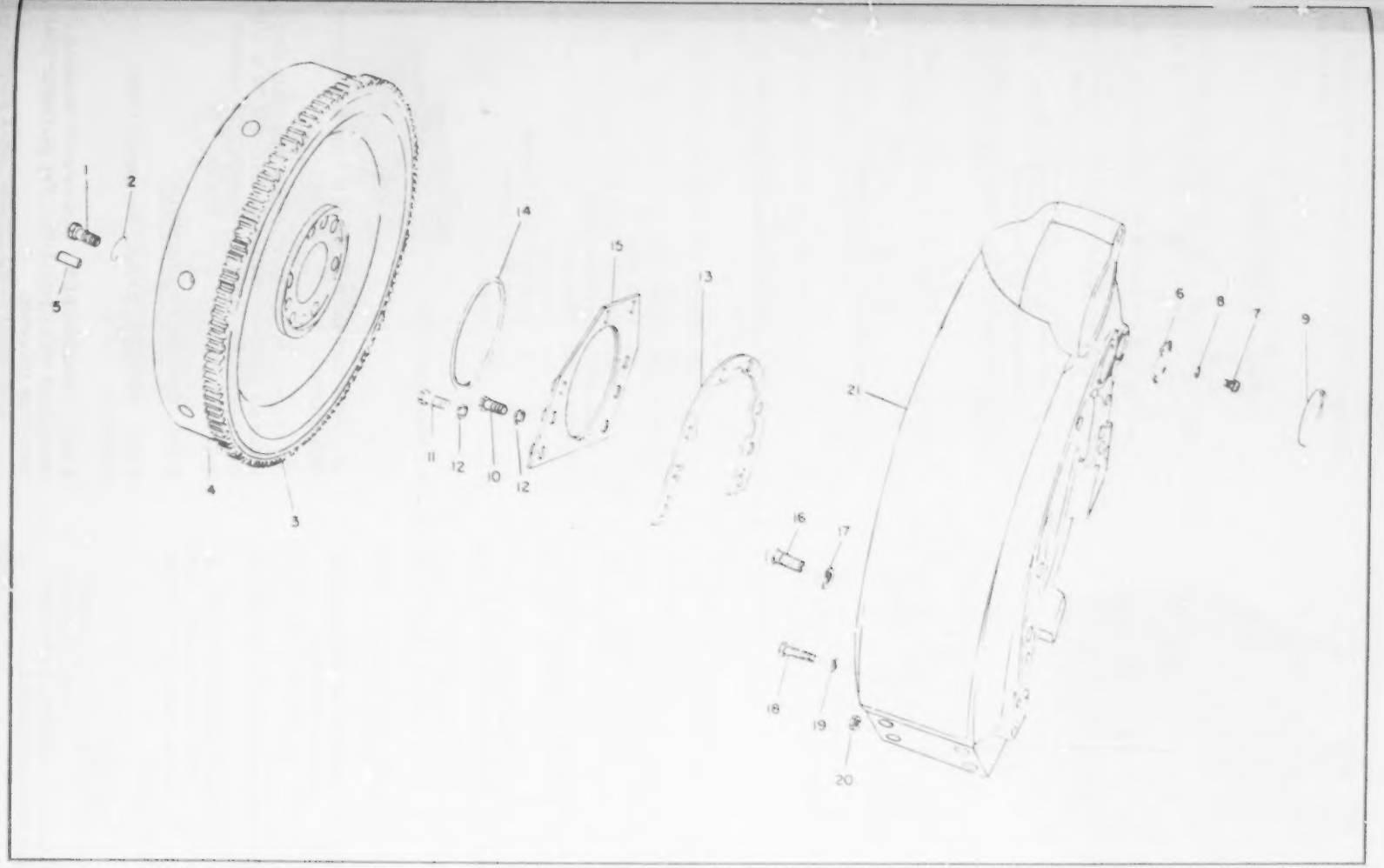
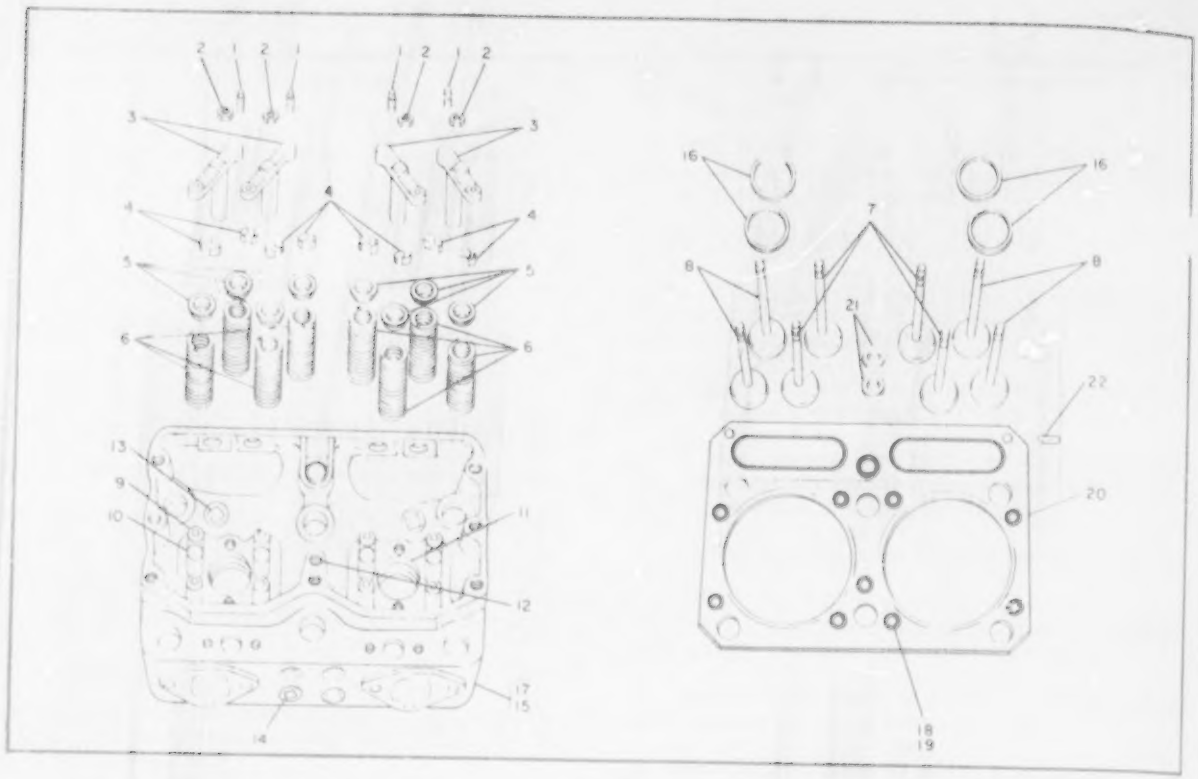


Figure 2-87. Size Marking On Flanged Injector Cup



1. Screw
2. Lockwire
3. Ring Gear
4. Flywheel
5. Pin
6. Cover
7. Screw
8. Lockwasher
9. Gasket
10. Screw
11. Screw
12. Lockwasher
13. Gasket
14. Rear Seal
15. Rear Cover Plate
16. Screw
17. Lockwasher
18. Screw
19. Lockwasher
20. Nut
21. Flywheel Housing

Figure 2-88. Flywheel and Cover Assembly



1. Screw
2. Nut
3. Valve Crosshead
4. Collet
5. Guide
6. Spring
7. Exhaust Valve
8. Intake Valve
9. Guide
10. Valve Cross Head Guide
11. Injector Sleeve
12. Plug
13. Plug
14. Plug
15. Fuse Plug
16. Exhaust Valve Seat Insert
17. Cylinder Head
18. Grommet
19. Retainer
20. Cylinder Head Gasket
21. Lube Pipe Gasket
22. Dowel

Figure 2-89. Cylinder Head Assembly

2-498. REASSEMBLY. Reassemble in the reverse order of disassembly. Note the following:

a. Make sure lever insert is securely seated.

b. Install rollers with 0.006 inch feeler stock beneath roller and next to lever as a support. Press pins through rollers and levers, then remove feeler stock. Secure with roll pins.

CAUTION

If new injector insert is installed, a new injector push tube also must be installed.

c. Make sure the injector is in center position on each assembly.

d. Push tubes that have become filled with lubricating oil should be drained by drilling 1/32 to 1/16 inch hole in tube 1 inch above where tube contacts ball insert.

2-499. CAMSHAFT ASSEMBLY.

2-500. SPECIAL TOOLS. No special tools required.

2-501. DISASSEMBLY. Disassemble camshaft in accordance with figure 2-95. Pay particular attention to the following:

a. Place camshaft in a press between V blocks.

b. Heat gear with heating torch to 300 degrees - 400 degrees F.

CAUTION

The 1/8 inch pipe plug (4) is an orifice plug. Do not mix with other pipe plugs.

2-502. CLEANING. Clean camshaft by washing with an approved cleaning solvent and drying with filtered compressed air. Be sure to clean oil passage in shaft center.

2-503. INSPECTION.

a. Inspect gear (1) for scuffed, nicked, burred and broken teeth.

b. Inspect thrust face of gear for scores, nicks, and scratches.

c. Inspect camshaft (5) for scuffed, scored, and cracked injector or valve lobes.

d. Inspect journals for excessive wear.

e. Check OD of journal. It should not exceed wear limits in table 2-5.

f. Inspect camshaft (5) for cracks.

2-504. TESTING. Test camshaft by Magnaflux per Military Specification MIL-M-11472.

2-505. REPAIR OR REPLACEMENT. Repair or replace any item noted defective during the inspection.

Figure 2-90. Rocker Lever Oiling Hole

Figure 2-91. Fuse Plug Examination

CAUTION

It is not recommended that this camshaft be reground.

NOTE

Only authorized replacement parts shall be used as specified in the related Illustrated Parts Manual.

2-506. LUBRICATION. During reassembly, lubricate as follows:

a. Coat camshaft thrust face and gear with Lubriplate or equivalent.

b. Lubricate camshaft valve lobes with oil, Military Specification MIL-L-9000.

2-507. REASSEMBLY. Reassemble in reverse order of disassembly.

2-508. CONNECTING ROD ASSEMBLY.

2-509. SPECIAL TOOLS. No special tools required.

2-510. DISASSEMBLY. Disassemble connecting rod assembly in accordance with figure 2-96. Pay particular attention to the following:

a. Remove retaining ring (6) from piston pin (7).

CAUTION

Piston must be heated before attempting removal of piston pin.

b. Immerse the assembly of piston pin. Piston and connecting rod in boiling water, then push pin (7)

from piston (8) using finger pressure or other suitable method. Do not drive or otherwise force pin from piston.

2-511. CLEANING. Clean connecting rod and piston components in dry cleaning solvent, Federal Specification P-S-661.

NOTE

Piston skirts are coated with plating that may blister if overheated. We recommend that water boiling point not be exceeded.

2-512. INSPECTION.

a. Inspect all parts for corrosion, visible damage and defects. Check the piston at the points shown in figure 2-97 for wear and damage.

b. Inspect threaded parts for stripping and burrs.

c. Insert each piston ring and compression ring in mating cylinder liner, seating it squarely with a piston head in an unworn surface of liner.

d. Measure ring gap with feeler gage. Ring gap clearance for two compression rings should be between 0.013 and 0.023 inch on upper ring and between 0.017 and 0.027 inch on lower ring.

CAUTION

Never file chrome plated piston rings, (when used, chrome-plated compression ring is always installed in top piston ring groove).

e. If necessary, file ends of compression rings to obtain minimum ring gap.

f. Using micrometers, inspect piston pin for evidence of wear. Pins should not be reused if out of round more than 0.001 inch or worn smaller than wear limits in table 2-4.

g. Check piston to liner clearance. Measure piston skirt diameter with a micrometer at right angle to piston pin bore. (A figure 2-97 for barrel ground pistons.) Measure straight or tapered ground pistons at point B, 1 inch below ring groove and C 1 inch above bottom of piston. Pistons should not be reused if worn more than indicated in wear limit table 2-4. Gaging should be done at temperatures between 70 degrees F and 90 degrees F. (31 degrees C and 32 degrees C.)

h. Piston pin bore checked at 70 degrees F should be as specified in table 2-4 and add 0.0005 inch per 10 degrees up to 90 degrees F.

NOTE

Be sure connecting rod and cap are kept mated at all times.

i. Hold a new ring flush with piston level, and insert a 0.006 inch feeler gauge. If gauge enters groove, wear is excessive.

j. Using a ball point micrometer, and dial indicator thickness gage inspect sleeve bearings for evidence of wear.

k. Discard worn rod bearings if chipped, flaked, or scored, or if wear is excessive. See table 2-4 wear limits.

l. Check bolts just under piston head for possible interference. The bolt head must rest squarely on milled surface of rod.

m. If connecting rod bolts have been tightened excessively, they may be permanently stretched in which case they must be discarded. Discard bolt if diameter at smallest point is less than 0.540 inch.

n. Discard all old bolts and nuts that have distorted threads.

o. Magnaflux connecting rod in accordance with Military Specification MIL-M-11472. If any defects are revealed, discard the connecting rod. (See figure 2-98).

p. Check connecting rod for defects with 1800 amperes longitudinally between plates. (AC equipments.)

q. Check rods for defects with 3000 - 3400 amper turns in a coil. Pay particular attention to the shad critical areas indicated in figure 2-98.

r. Apply one and one half percent wet solution wh current is on. Make visual inspection after each application of current.

s. Assemble connecting rod and tighten nuts sequencially per values listed in table 2-9. If a hardened washer is used, follow second sequence in this same table.

t. Diameter shall be within limits specified in figure 2-98. Out of roundness shall not exceed 0.00 inch.

u. Inspect pin bushing using bore gage. Limits f a new bushing are 2.0010 - 2.0015 inches. Worn limits at any point shall not exceed limit specified i table 2-4.

v. Inspect connecting rod alignment using a check ing fixture, mandrel set, and a dial indicator. Ma mum bend and twist, side clearance on shaft, clear ance between connecting rod and piston boss shall n exceed limits in table 2-4.

w. Length of connecting rod shall be as specified table 2-4.

x. Crank pin bore must be checked with an inside micrometer:

1. The worn bore diameter must be 3.2722 to 3.2736 inches up to 30 degrees on either side of parting line. See figure 2-99.

2. The worn bore diameter must be 3.2722 to 3.2732 inches beyond 30 degrees on either side of parting line.

NOTE

Failure to comply with above dimensional specifications is automatic justification to replace connecting rod assembly with a new component.

y. Connecting rods have a weight code letter stamped on rod cap and must be matched with other rods with same code letters.

2-513. TESTING. No testing required.

2-514. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection.

CAUTION

Reboring of piston pin bores and use of oversize pins is not practical because the misalignment that results from such practice will cause seizure of piston or failure of connecting rod bearings.

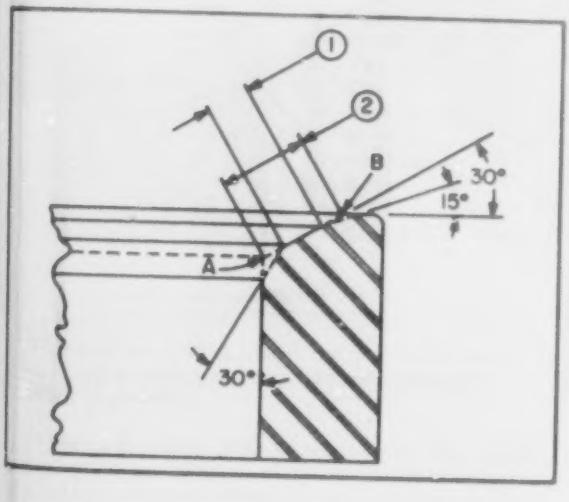
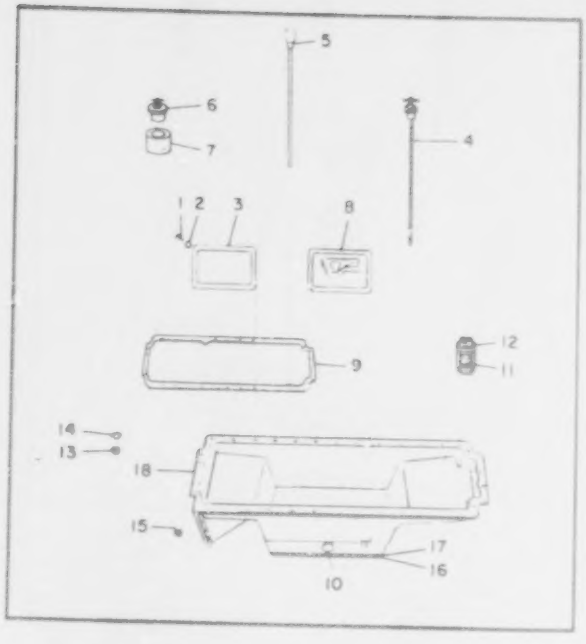


Figure 2-92. Valve Seat Insert Cross Section



1. Screw
2. Lockwasher
3. Gasket
4. Liquid Level, Gauge Rod Cap
5. Oil Gage Tube
6. Oil Fill Cap
7. Oil Filter Tube
8. Oil Filter Bracket
9. Gasket
10. Tube
11. Suction Screen
12. Screw
13. Pipe Plug
14. Gasket
15. Plug
16. Oil Pan Cover Plate
17. Gasket
18. Oil Pan

Figure 2-93. Oil Pan and Gage Assembly

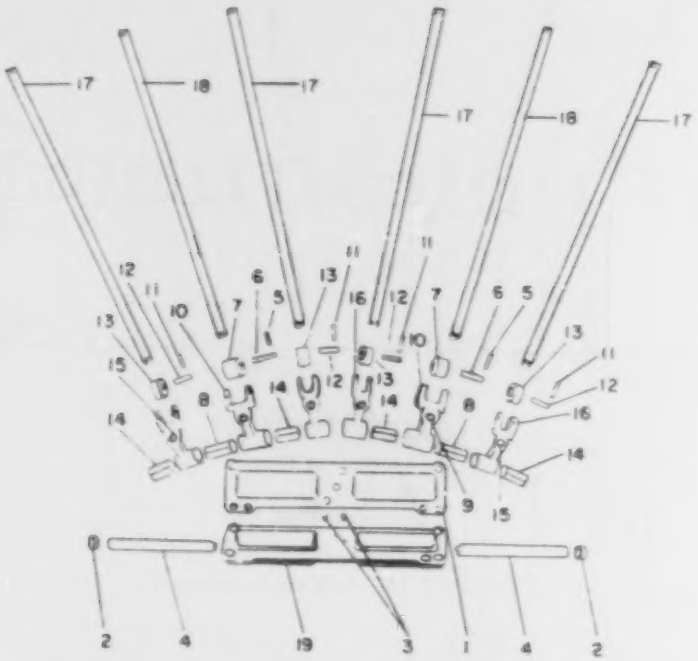
NOTE

Only authorized replacement parts shall be used as specified in related Illustrated Parts Manual.

Repair procedures for both piston and connecting rod are as follows:

a. Replace piston pin if outside diameter exceeds dimensions in table 2-4 or if its out-of-roundness exceeds the specified limits.

b. Regroove top ring groove. If piston dimensions are within limits except for worn top ring groove, groove can be machined to use an over width ring.



1. Gasket
2. Expansion Plug
3. Screw
4. Shaft
5. Pin
6. Pin
7. Cam Roller
8. Bushing
9. Bushing
10. Lever
11. Pin
12. Pin
13. Cam Roller
14. Bushing
15. Bushing
16. Lever
17. Push Rod
18. Push Rod
19. Housing

Figure 2-94. Housing Assembly, Cam Follower

NOTE

This applies only to aluminum pistons without top ring groove inserts. Use extreme care when regrooving.

. Set up piston in lathe or similar device. Make rtain piston is held securely without damaging or storting machined surfaces. Install the approved ooving tool in lathe.

. Clean up bottom face of groove, removing as all amount of material as possible. Machine face of groove to nearest oversize.

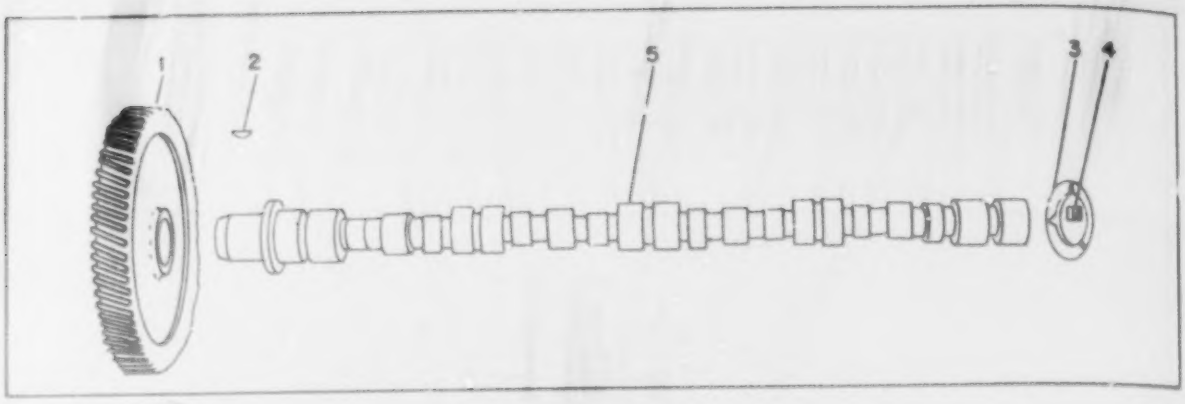
CAUTION

Limits must be held accurately for satisfactory ring performance.

e. Hold machined surfaces within 0.0015 inch total indicated runout. Stamp letters OW after part number on piston crown to indicate over width ring.

f. Replace worn pin bushings using mandrel.

g. Press pin bushings into both sides of connecting rod. (When using a one piece bushing, be sure to line up the oil holes.) Prior to boring, fill lubricating holes with soap to keep out shavings.



1. Gear
2. Key
3. Thrust Ring
4. Plug
5. Cam Shaft

Figure 2-95. Camshaft Assembly

h. Mount connecting rod in boring machine, and bore pin bushings to 2.001 - 2.0014 inch ID. Check size using plug gage.

i. Chamfer pin bushing inside edge to 1/16 inch deep by 45 degrees. Remove sharp edges around oil grooves with a scraper.

j. Clean shavings and soap from pin bushings with compressed air. Inspect rebushed and rebored connecting rod by following instructions in paragraph 2-512.

k. Remove nicks and dents which are less than 1/16 inch deep by grinding or filing with half-round file. Radius must be 1/2 inch or more. Blend radii at ends of cut. Scrap rod if dents are deeper than 1/16 inch.

l. Check bolt pin radius and round edges at ends to 0.045 - 0.060 radius. See figure 2-98. Upper limit of 0.120 radius within 0.390 limits covers natural forging contour above edge A. The edge of bolt seating pad within 0.390 inch limits below edge A should not be rounded over 0.060 inch.

m. Edge A which lies with the 0.390 inch limits should be rounded 0.005 - 0.060 inch radius and be free of sharp edges.

n. Check piston rod pin bore at the points shown in figure 2-98. If piston rod pin bore does not check within specified limits it must be resized to salvage the rod. The connecting rod length must be 12.000 inch or more to permit resizing. If rod is less than 11.991 inch it cannot be reworked and must be scraped.

o. Remove cap and surface grind or mill a maximum of 0.009 inch stock from machined face of rod.

p. A maximum of 0.009 inch stock may be machined from cap surface.

q. Parts must be clamped securely during this operation to insure proper contact of entire mating surfaces and proper alignment of bores for rod bolt holes.

r. If piston rod pin bore does not check within specified limits it must be resized to salvage rod. The connecting rod length must then be restored to 11.998 - 12.000 inches center-to-center to provide proper engine compression.

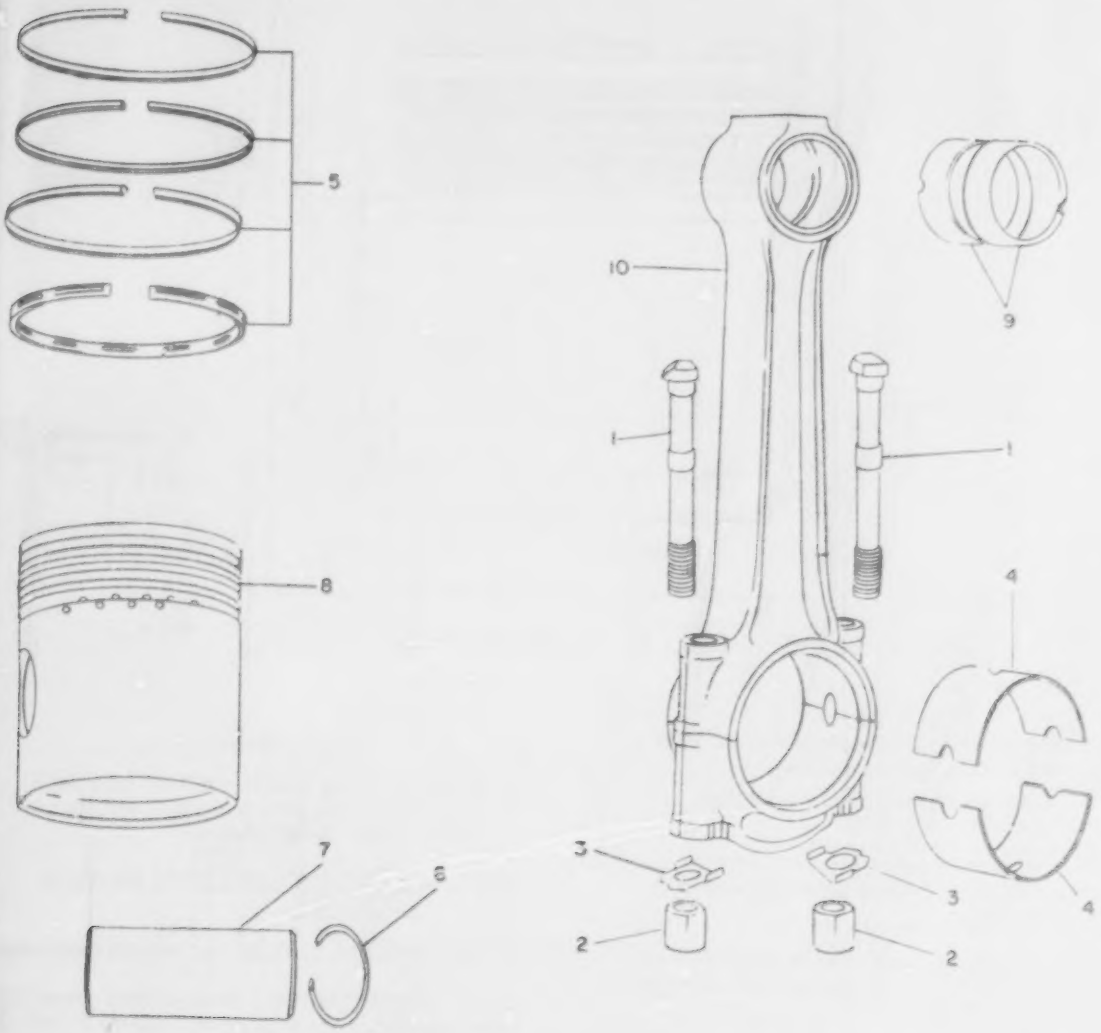
s. Remove piston pin bushing as instructed in step f.

t. Assemble connecting rod assembly as instructed in paragraph 2-512 step s.

u. Recheck connecting rod length on checking fixture. If connecting rod has been sized previously, it will be shorter than standard by 0.018 inch or more and can not be resized again.

v. If connecting rod is suitable for resizing crankpin bore, remove cap and surface grind or mill 0.018 inch stock from mating faces of rod cap. A fixture is required for this operation to insure that entire mating surfaces will contact after reassembly and that bores for bolts will be straight. Bolt holes must be vertical to machined mating faces.

w. Reassemble the connecting rod assembly as instructed in paragraph 2-512 step s.



1. Bolt
2. Nut
3. Lockplate
4. Connecting Rod Bearing
5. Ring Set
6. Retaining Ring
7. Piston Pin
8. Piston
9. Bushing
10. Connecting Rod

Figure 2-96. Connecting Rod Assembly

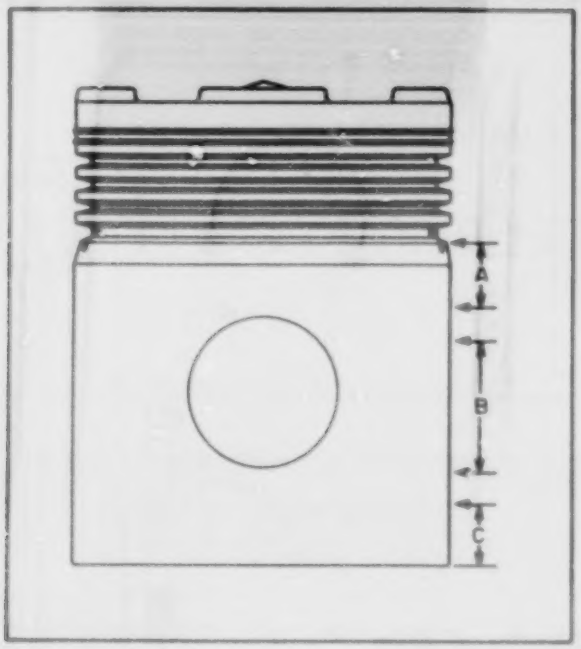


Figure 2-97. Piston Check Points

x. Line bore or grind the pin bore to 3.2722 - 3.2732 inches using boring machine.

NOTE

A fixture is required to insure alignment of bores within 0.004 inch TIR as measured by checking fixture.

y. Polish finished surface to 40 microinch or better. Restore fillets by milling off to dimensions shown in figure 2-98.

2-515. LUBRICATION. No lubrication required.

2-516. REASSEMBLY. Reassemble in the reverse order of disassembly. Note the following, and see table 2-9 for connecting rod nut tightening sequence.

a. Install one snap ring (6, figure 2-96) in piston pin bore groove.

CAUTION

Never drive piston pins in pistons. Driving may cause distortion of the piston sufficient to cause seizure of the piston in the cylinder liner.

b. Heat piston in boiling water or in an oven at 210 degrees F or below and install pin through piston and connecting rod pin bore before it cools.

NOTE

Piston pin fit is 0.0001 - 0.0003 inch at 70 degrees F which prevents pin assembly unless piston is heated.

2-517. CRANKSHAFT AND MAIN BEARING ASSEMBLY.

2-518. SPECIAL TOOLS. No special tools required.

2-519. DISASSEMBLY. Disassemble crankshaft and main bearing in accordance with figure 2-100. Pay particular attention to the following:

a. If gear (21) is chipped, cracked, broken, or worn, remove nut (19) and lockwasher (20) from crankshaft (24).

b. Attach a circular split collet type puller behind crankshaft gear and apply 75 to 100 ft. lbs. on puller screw.

c. Heat gear with a heating torch - not a cutting torch to 300 degrees - 400 degrees F. The gear will expand and then can be removed together with the key (22).

2-520. CLEANING.

a. Clean all parts using dry cleaning solvent, Federal Specification P-S-661. Dry with clean, filtered, compressed air.

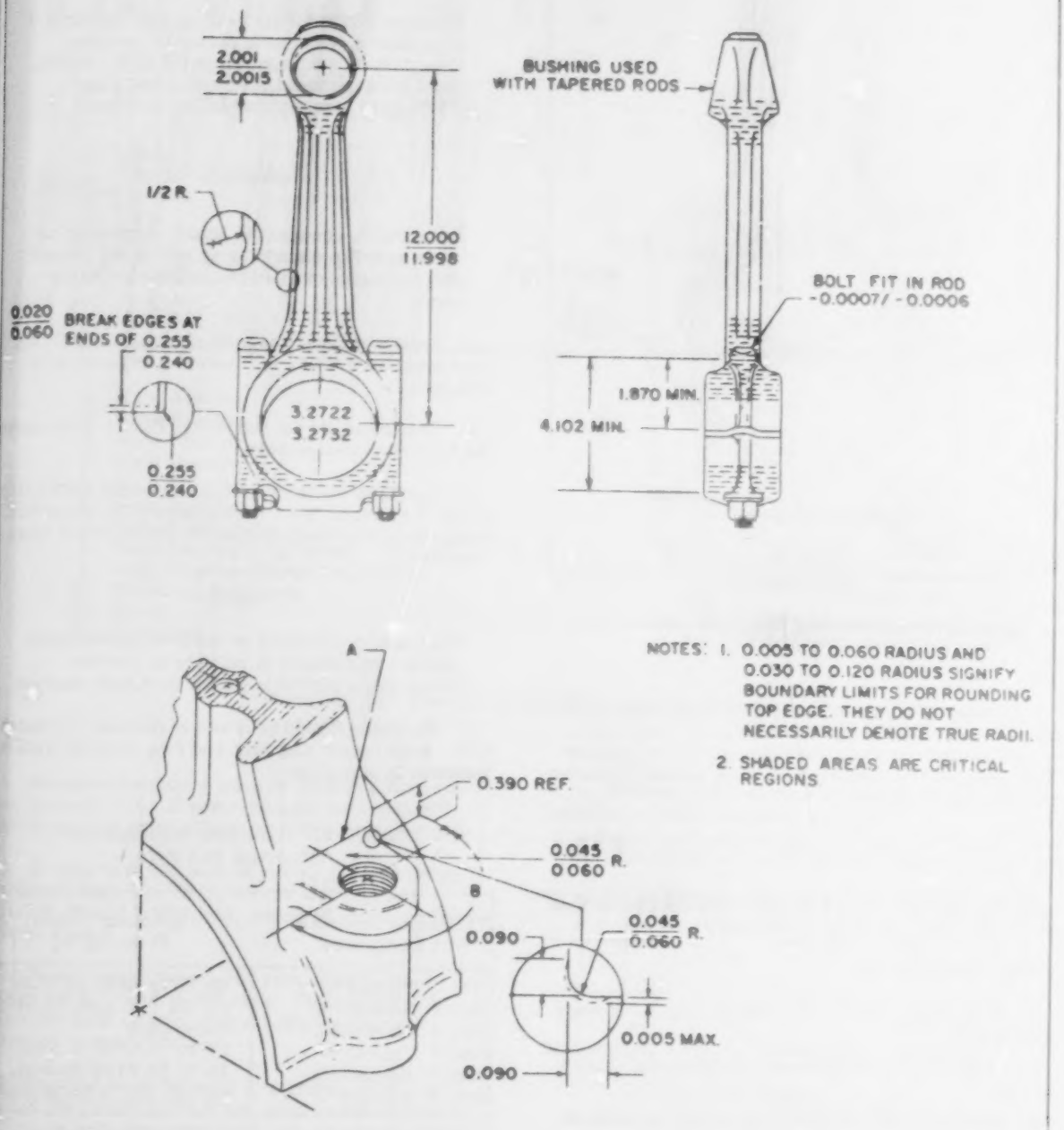


Figure 2-98. Connecting Rod Inspection and Rework Sheet

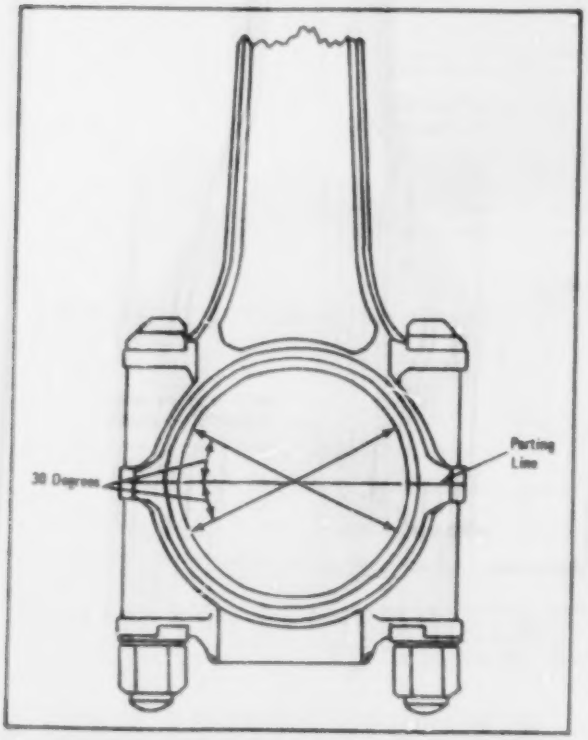


Figure 2-99. Connecting Rod Bore Check Points

b. Clean all oil passages by first removing pipe plugs then pushing a thin rod with a lint free cloth wound around one end slowly through the oil gallery. The cloth may be soaked in cleaning solvent to assist the cleaning process.

c. Severe carbon or sludge buildup may require several cleanings.

d. Use extreme care when cleaning bearing shells and never leave soaking for extended periods.

2-521 INSPECTION.

a. Inspect all parts for corrosion, visible damage and defects.

b. Inspect threaded surfaces for stripping, burrs, and dirt.

c. Bearing shells should be inspected as outlined below:

CAUTION

Never use lead ribbon or feeler gage to check main bearing clearance. Doing so will result in unnecessary damage to the bearing shell. Always use a suitable dial indicator thickness gage, ball point micrometer to measure bearing shell.

d. Discard main bearings that are worn more than 0.002 inch or if chipped, flaked, or scored.

NOTE

A properly fitted main bearing will appear dull gray after a reasonable period of service, indicating it is running on an oil film. Bright spots indicate metal-to-metal contact and black spots indicate excessive clearance.

CAUTION

Under no circumstances should an attempt be made to scrap main bearing shells nor should they be lapped or filed to increase oil clearances.

e. Total worn maximum oil clearance should not vary more than 0.002 inch between adjacent main bearings.

f. Crankshaft thrust half-rings (7) are best checked during engine reassembly.

g. Carefully examine crankshaft thrust flange (13) at no. 7 journal. If surface is scored or scratched, flange should be reground and oversize thrust rings installed.

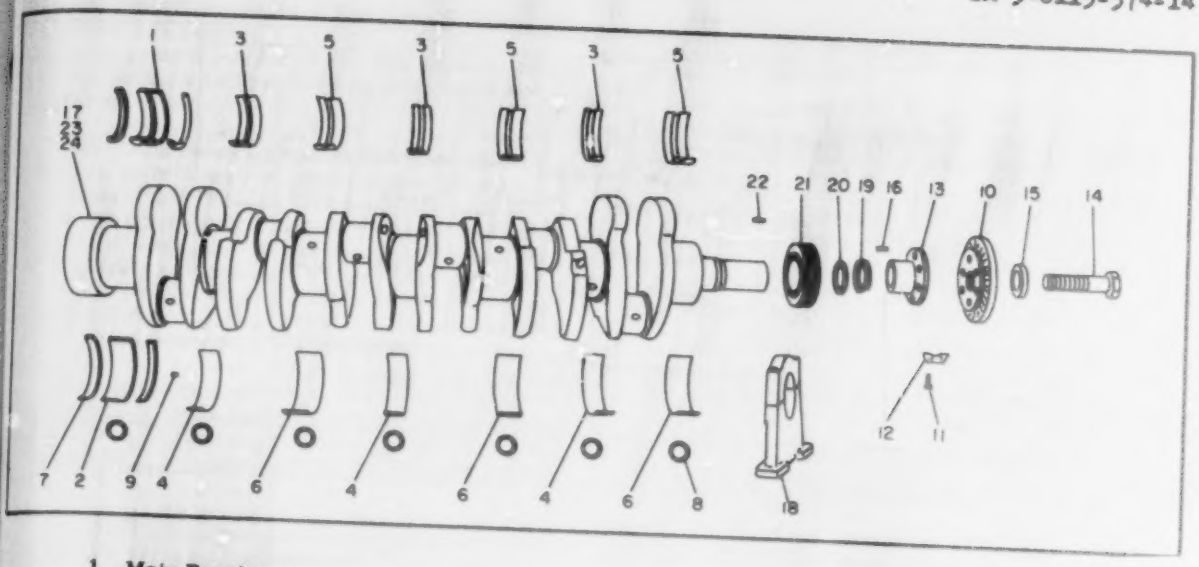
NOTE

Reground crankshafts or those with oversized thrust rings should be marked so correct thrust rings will be installed in proper position.

h. Markings should be stamped on rear crankshaft web. Both thrust ring size and ring location must be included in stamping.

Table 2-9. Tightening Sequence For Connecting Rod Nuts

Tightening Sequence With Lockplates	Tightening Values Ft-lb [kg m]
Step 1 Tighten to	70/75 [9.6810/10.3725]
Step 2 Advance to	95/105 [13.1385/14.5215]
Step 3 Loosen all	Completely
Step 4 Tighten to	25/30 [3.4575/4.1490]
Step 5 Advance to	70/75 [9.6810/10.3725]
Step 6 Advance to	95/105 [13.1385/14.5215]
Tightening Sequence With Hardened Washer	**Tightening Values Ft-Lb [kg m]**
Step 1 Tighten to	70/75 [9.6810/10.3725]
Step 2 Tighten to	140/150 [19.3620/20.7450]
Step 3 Loosen all	Completely
Step 4 Tighten to	25/30 [3.4575/4.1490]
Step 5 Advance to	70/75 [9.6810/10.3725]
Step 6 Advance to	140/150 [19.3620/20.7450]



1. Main Bearing
2. Main Bearing
3. Main Bearing
4. Main Bearing
5. Main Bearing
6. Main Bearing
7. Thrust Half-Ring
8. Main Bearing Ring Dowel
9. Main Bearing Thrust Ring Dowel
10. Vibration Dampener
11. Screw
12. Lockplate
13. Flange
14. Screw
15. Retainer
16. Key
17. Crankshaft Oil Seal
18. Front Engine Support
19. Nut
20. Lockwahser
21. Helical Gear
22. Key
23. Pipe Plug
24. Crankshaft

Figure 2-100. Crankshaft and Main Bearing Assembly

Measure for flange wear by checking K dimen- n figure 2-101. If wear does not exceed 0.003 h at any one point, flange condition is acceptable.

If wear is 0.003 inch or more, regrind flange estore flatness. If total wear and regrinding s not exceed 0.005 inch, standard thrust rings be used.

If worn more than 0.007 inch, flange should be nd for 0.010 or 0.020 inch. Oversize thrust s are built up with electric arc welding and round to specifications.

Regrind must clean up a minimum of 90 per- of the thrust surface and must result in main- ng an installed crankshaft end clearance below 5 inch.

Magnetic Inspection.

Magnaflux crankshaft in accordance with Mili- Specification MIL-M-11472. Refer to steps 1 3 for operational procedures and limits of tability.

1. Wet complete surface with magnetic particle suspension before applying current.

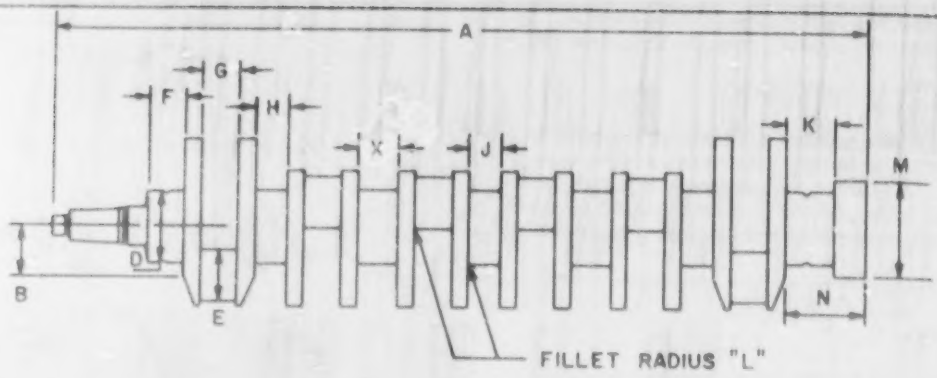
2. The following currents shall be used:

Direction of Defect	Longitudinal	Circumferential
dc or rectified ac	1200 amp	3600 - 4000 ampere turns
ac equipment	1400 amp	4200 - 1700 ampere turns
Magnetizing method	head shot	coil shot

NOTE

Ampere turns is amperage flowing through coil multiplied by number of turns in coil. Above is for a 4 turn coil.

3. Flow magnetic particle suspension over part in advance of placing part through coil. Turn coil current on and move coil full length of part.



A	B	D	E	F	G	H	X	J
51-13/16	2.995 3.005	4.4985 4.5000	3.1235 3.1250	2-7/16	2.375 2.378	2	2-1/2	2

K	L	M	N
3.001 3.003	0.172 0.195 R	5.998 6.000	5.151 5.163

Figure 2-101. Crankshaft Dimensional Check Points and Tolerance

4. If crankshaft parts are within 2 or 3 inches of coil ID ample magnetization will be obtained if 3 shots of current are passed through coil while it is at each end and center of part length.

5. Limits of Acceptability.

(a) Unless otherwise stated, limits of acceptability apply only to light slag or oxide stringers usually defined as inherent inclusions. Obvious cracks and circumferential or transverse defects are not acceptable.

(b) Limits listed in following steps must be maintained with region C (Critical Region) (13, figure 2-102). Dimensional value of C is vertical distance measured downward from crankpin centerline (22) and extending longitudinally for all crank webs between region (3) on crankpin and region (1) on main journal.

(c) Indications located less than 1 inch from major axis or centerline (22) of adjacent web (measured circumferentially) must not exceed the following limits.

(1) Light indications in or entering fillets (11) are acceptable if not more than 1/8 inch long (open) or 1/4 inch long subsurface.

(2) Light open indications on crankpin (21) and main journal walls (7) or bearing surface that extend closer than 1/8 inch (3.1750 mm) to fillets (11), but do not enter fillets, are acceptable if 3/16 inch. (4.7625 mm) long or less. Light subsurface indications are acceptable.

(d) Indications located more than 1 inch (25.4000 mm) from major axis or centerline (22) of adjacent web (measure circumferentially) must not exceed following limits.

(1) Light open indications in or entering fillets (11) are acceptable if 3/16 inch (4.7626 mm) long or less. Light subsurface indications are acceptable.

(2) Light open indications crankpin (21) and main journal walls (7) or bearing surfaces that extend closer than 1/8 in. (3.1750 mm) to fillet (11), but not enter fillet, are acceptable if 1/4 in. (6.3500 mm) or less. Light subsurface indications are acceptable.

(3) Nicks on corners (23) of webs (5) are not acceptable. The part will be acceptable if nick can be removed by grinding a 1/8 inch (3.1750 mm) radius on corner.

(4) Imperfections on web periphery (6) may be ground out to a depth of 1/8 inch (3. 1750 mm) maximum using a 1-1/2 inch (38. 1000 mm) minimum radius grinding wheel provided balance limits are maintained.

(5) Light open indications that pass within 3/16 inch (4. 7625 mm) of crankpin hole (9) are acceptable if 1/2 inch (12. 7000 mm) long or less and do not enter oil chamber or intersect 45 degree ±10 degree diagonal. Only those subsurface indications that lie closer than 1/16 inch (1. 5875 mm) to surface (measured at the chamfer at a 45 degree ±10 degree diagonal are not acceptable). All other subsurface indications are acceptable.

(e) Light open indications that enter chamfer of any main bearing oil hole (20) are acceptable if they are 3/8 inch (9. 5250 mm) or less. Subsurface indications ending in a main bearing oil hole are acceptable.

(f) Fine subsurface, salt and pepper type indications are permitted on upper and lower sides of crankpins (21) on trimming line.

(g) Open longitudinal indications within region (1) which are less than 1-1/8 inch (38. 5750 mm) on main journals and 7/8 inch (22. 2250 mm) long on crankpins (3) are acceptable after sharp edges have been stoned 0. 002 - 0. 004 inch (0. 0508 - 0. 1016 mm) below journal surface.

(h) Longitudinal subsurface indications within area 91 or 3 are acceptable.

(i) Parallel subsurface indications are acceptable.

(j) Indications that contain loose or foreign particles or voids left by such particles are not acceptable.

(k) Parallel subsurface indications are acceptable.

(l) Not more than three open indications are to appear on any one journal (1) or crankpin (21). Scattered small open or subsurface indications, four per crankpin (21), and six per main bearing (1) 7/8 inch, (3. 1750 mm) long or less. If not forming part of a long intermittent indiction or entering an oil hole (9 or 20) or fillet (11) will not be counted as indications in arriving at total number permitted. However, if in addition to showing maximum number of acceptable indications for the whole crankshaft the part also shows many widely scattered short indications. It must be rejected.

(m) An inclusion which is intermittently open and subsurface shall be considered and measured as an open indication after the original indication is ground off. The entire indication must first meet requirements for subsurface limits.

(n) Open and subsurface indications on counterweights and crankthrow bevel outside the critical region are acceptable.

(o) Seams or indications outside critical region that extend over crank web periphery (6) but are not visible on crankpin wall are acceptable.

(p) Open seams on web periphery that show visual depth on crankpin wall (10) may be removed from web periphery within 1/2 inch (12. 7000 mm) radius wheel, provided at least 1/16 inch (1. 5875 mm) wall remaining above crankpin fillet (11) after repair and balance limits are maintained.

(q) Indications due to weld defects are not acceptable in counterweight welds. Indications at corner (23) may be ground out and blended to depth not exceeding 1/4 by 5/8 inch (6. 3500 by 15. 8750 mm) long.

(r) Open longitudinal indications in flywheel and thrust flange fillets longer than 3/8 inch (9. 5250 mm) are not acceptable.

(s) Limits of indications on oil seal surface which when wiped clean, do not show sharp edges are acceptable.

6. After inspection where coil shot is used, give crankshaft lead shot to put magnetic poles at ends of crank, not throws. The residual magnetic field should not exceed two units on the magnaflux field indicator or equal.

2-522. TESTING. No testing required.

2-523. REPAIR OR REPLACEMENT.

Repair of the detail parts of the crankshaft assembly is impractical and should not be attempted, except in the following instances:

a. If inspection reveals that crankshaft is worn to point where it must be reground and the magnetic inspection shows that it is suitable for regrinding. Grind crankshaft to next standard undersize.

NOTE

Before Regrinding:

1. All journals should be checked for hardness and must check within 40 to 50 Rockwell C.
2. If crankshaft journals check below 40 Rockwell C. Crankshaft should be hardened to 0. 090 inch (2. 2860 mm) minimum depth and 45 to 50 Rockwell C before regrinding.
3. This check should also be performed after any bearing failure even though there may have been no seizure or crankshaft discoloration.
4. Soft crankshaft journals are more susceptible to high wear rate and breakage than those properly hardened.
5. Main bearings and rod bearing are available in 0. 010, 0. 020, 0. 030, and 0. 040 inch undersized.

b. If crankshaft thrust flange is worn, repair as outlined in preceding paragraph.

CAUTION

Grind only worn thrust face. Install oversize thrust rings on the wearing side only. Failure to do so will move operating position of crankshaft and cause extremely high wear.

c. Regrind crankshaft to undersize and hold to specifications shown in figure 2-101.

NOTE

Fillets add greatly to strength of crankshaft. Reducing fillet radii or undercutting subtracts materially from that strength. Conversely, if fillets are larger than those specified, bearing shells may be squeezed and will fail very quickly.

d. A limit of 0.030 inch over the maximum new crankshaft main bearing width specification (figure 2-101) shall apply in regrinding.

e. The pin wall heights are not to be lowered to less than 0.010 inch from pin checks in regrinding pin bearing width on all crankshafts.

f. Maximum runout on thrust wall of thrust main bearings shall be 0.002 inch TIR.

g. Gear fit diameter is acceptable when 0.002 inch total indicator runout is not exceeded in relation to adjacent main bearing.

h. If rear oil seal running area of rear flange requires more than 0.003 inch grinding, oil seal area may be step ground to a maximum of 0.010 inch under new crankshaft specifications within distance "B" figure 2-103. The ledge area C must be chamfered 0.040 - 0.060 inch. Plunge grind to a 10/12 RMS finish. Do not polish.

i. Runout on flange not to exceed 0.002 inch TIR.

j. Flywheel pilot or flywheel adapter pilot (0.40 inch) in width area A, figure 2-103 on all crankshafts must not exceed 0.003 inch undersize. Runout on rear flange is not to exceed 0.002 inch.

k. The following areas on crankshaft may be hard chrome plated. Front taper, gear fit surface, rear oil surface, and flywheel flange surface. Proceed as described in steps e. thru h.

CAUTION

Do not plate bearing journal surface.

l. Free surfaces to be plated from pits, tool marks, and all irregularities. Preserve all bevels chamfers, radii.

m. If necessary, grind surfaces undersize before plating to produce minimum finished plating thickness. Plating thickness must be 0.002 - 0.015 inch finish to standard diameter.

n. Chemically clean surfaces before plating.

CAUTION

Protect surfaces not being plated. Make certain that drilled passages are not contaminated with protective materials used.

o. Plating must be accomplished in a continuous operation.

p. After surfaces have been plated, heat at 375 degrees F (190 degrees C) for three hours to remove effects of hydrogen embrittlement.

q. Magnaflux the crankshaft as described in inspection procedures.

r. Check drilled passages and unplated surfaces to make certain they are free of plating and protective materials.

2-524. LUBRICATION. No lubrication required.

2-525. REASSEMBLY.

Reassemble in reverse order of disassembly plus the following supplementary instructions.

a. Place crankshaft (24, figure 2-100) in V blocks and install key (22).

b. Position helical gear (21) on crankshaft.

c. Heat gear with heating torch - not cutting torch - to 400 degrees F. Lubricate flange with Lubriplate or equivalent and drive gear onto shaft with a piece of tubing.

d. Install lockplate and nut.

CAUTION

It is extremely important to check the crankshaft oil drilling holes to insure that pipe plugs removed during the cleaning process have been reinstalled.

e. Plugs should be tightened to 5 ft. lbs. torque and staked by making 1/64 inch indentation at outside diameter of threads with center punch.

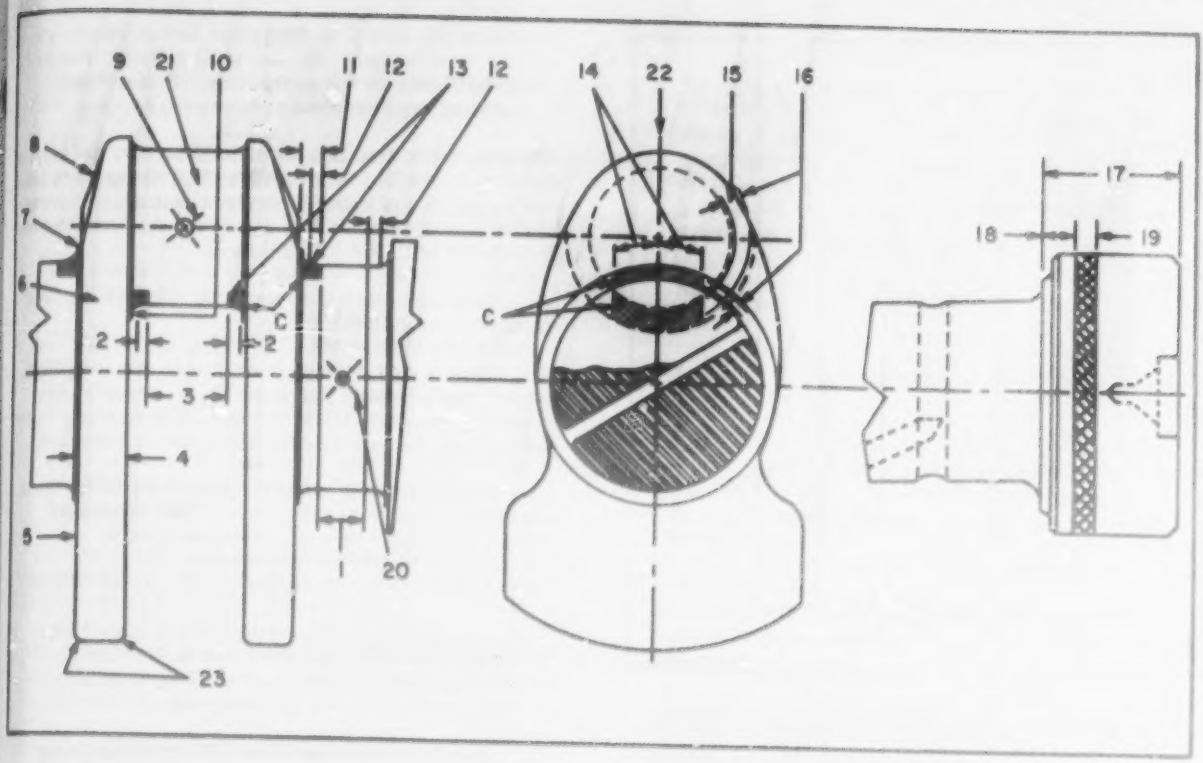


Figure 2-102. Crankshaft Magnetic Inspection

2-526. CYLINDER BLOCK ASSEMBLY.

2-527. SPECIAL TOOLS. No special tools required.

2-528. DISASSEMBLY. Disassemble cylinder block assembly in accordance with figure 2-105. Pay particular attention to the following.

a. Use a liner puller with correct size plate to remove cylinder liners.

b. Remove all pipe plugs from oil and water passages, galleries etc.

2-529. CLEANING. Clean cylinder block in the following manner:

a. Clean all parts using dry cleaning solvent, Federal Specification P-S-661. Dry with clean, filtered, compressed air.

b. Remove rust and scale from cylinder liner exterior using a wire brush.

c. Clean oil passages in cylinder block using a swab wet with dry cleaning solvent, Federal Specification P-S-661. Wrap the swab around a wooden rod. Remove all pipe plugs. Slide the wooden rod through the oil passage.

d. Blow out cylinder head and main bearing screw holes with clean, filtered, compressed air.

e. Clean air vent hole (no. 1 cylinder) that opens into water pump cavity.

f. Clean lower liner bore with sandpaper or sanding drum powered by an electric drill. Emery cloth may be used if bore contains ridges. Be sure to remove nicks and burrs that would damage liner packing rings as liner is installed.

NOTE

Cylinder head capscrew holes in block are counterbored to depth of cylinder liner counterbore to prevent distorting and forcing cylinder out-of-round when head screws are tightened. All dirt and oil must be removed from holes to prevent breaking the cylinder block when screws are installed.

2-530. INSPECTION. Inspect cylinder block as outlined below.

a. Inspect all parts for corrosion, visible damage and defects.

b. Inspect bushing (1, figure 2-105) for evidence of wear, chips, score marks and scratches.

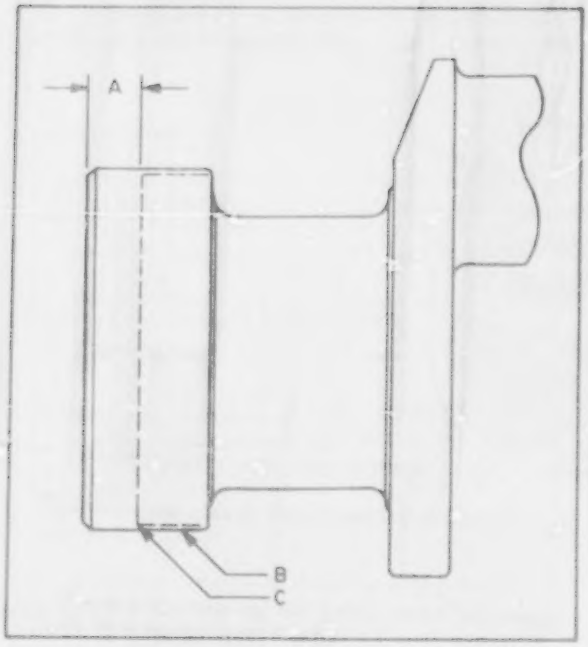


Figure 2-103. Rear Seal Regrind Specifications

c. Inspect bushing (2) for evidence of wear and poor fit in cylinder block (29).

d. Inspect cylinder counterbore diameter dimensions. New dimensions are 6.1420 minimum to 6.1260 maximum. If counterbore exceeds these limits for the top 0.250 inch depth, mark block for machining for oversize flange liners.

e. Counterbore depth so installed liner will assemble to correct protrusion as follows:

Minimum	Maximum	Worn Limit
0.434 inch	0.435 inch	0.4970 inch

If worn beyond worn limit cylinder block must be replaced.

f. Installed cylinder liners must protrude 0.004 - 0.006 inch above block.

NOTE

Do not include head on top of liner flange in taking measurement.

g. Inspect liner (27) for evidence of wear and poor fit in cylinder block (29). Lower liner to block clearance minimum 0.002 inch, maximum 0.008 inch. Lower liner bore ID minimum 5.749, maximum 5.751 inch.

NOTE

These limits do not apply with cylinder head installed and tightened to operating torque.

h. Inspect milled face of main bearing cap (12) for distortion. Milled face of caps must always rest on mating portion of block to prevent distortion during tightening. (Main bearing caps have an interference fit to block of 0.004 - 0.007 inch).

i. Assemble main bearing caps, lockplates, and capscrews to cylinder block.

j. Using a dial bore gage or inside micrometers, inspect bushing bore horizontally, vertically, and diagonally for indication of wear. The bushing bore inside diameter shall be as specified in table 2-4.

k. Using a main bushing alignment fixture, check alignment of main bushing bore. The alignment fixture shall pass through all bores freely.

NOTE

If it is definitely determined that a main bearing cap has been distorted and is preventing the alignment fixture from passing through, mark cylinder block for reboring.

l. Magnaflux cylinder liner (27) in accordance with Military Specification MIL-L-11472. If any defects are revealed, discard the liner.

m. Inspect cylinder liner for defects using chalk dust and alcohol or whiting. Cracks will be revealed by discoloration of the chalk or whiting in the defective area.

n. Inspect underside of cylinder liner flange for dents, pitting, fretting and excessive corrosion.

Figure 2-104. Cylinder Liner Crosshatch Pattern

o. Using a dial bore gage or inside micrometers, inspect cylinder liner bore for indication of wear. If cylinder liner is worn more than specified in table 2-4 replace or regrind to next oversize.

p. Inspect cylinder block (29) for cracks by painting with chalk dust and alcohol or whiting.

NOTE

Oil seepage will discolor chalk at any cracked location.

q. Inspect cylinder block for evidence of corrosion.

NOTE

Corrosion most frequently occurs on portions of block nearest cylinder liners and is evidenced by pitting.

r. Inspect oil and water passages in cylinder block for corrosion. Water holes not eroded more than 1/16 from edge of hole can be bushed.

s. Check for erosion within 1/32 to 3/32 inch from liner counterbore. If not too deep, block may be resurfaced.

2-531. TESTING. No testing required.

2-532. REPAIR OR REPLACEMENT. Replace any item noted defective during the inspection. Repair various components of the cylinder block assembly as follows:

a. Replace camshaft bushings if beyond wear limits in table 2-4.

NOTE

Camshaft bushing at no. 1 gear end is wider. All others are the same.

b. Drive bushings into position so oil holes are aligned. (A length of drill rod can be used to check oil hole alignment from main bearing hole).

c. Bushing for number 7 must be pressed in so it is away from rear face of block so oil can drain from drain hole at end of camshaft to prevent hydraulic lock.

d. Cylinder liners may be reused if found within wear limits in table 2-4, but should only be reworked to the next oversize increment.

e. Remove top ridge of cylinder liner with ridge cutter.

f. Remove glaze from liner with Sunnen UN-60 universal honing stand, Sunnen AN-111 cylinder hone and Sunnen AN-201 coarse finishing stone set or equivalent.

NOTE

Stroking speed required to produce a 35 degree to 45 degree crosshatch is approximately 50 strokes per minute. Refer to figure 2-104 for pictorial view. This pattern can only be obtained with a Sioux no. 1560 heavy duty drill with a 300 r.p.m. no load speed, or equivalent rated low speed drill motor.

CAUTION

Liners must not be ground larger than 0.040 inch oversize.

g. After liners have been honed, they must be thoroughly cleaned with solvent, steam cleaner or hot water and soap. It is recommended that the cleaning operation be ended by scrubbing bore with a bristle brush to remove as much honing debris as possible. Blow liners dry with compressed air.

h. Coat liner bores with generous amount of lubricating oil. Let stand for 10 minutes before next step.

i. Use white paper towels to remove lubricating oil from liner bores. Note gray and even black residue that appears with oil on white towel. This is honing debris that remained on liner walls. Repeat this cleaning procedure several times until no trace of honing debris is evidenced on the paper towels.

NOTE

This cleaning process in the most important single item with respect to liner rework and cannot be overemphasized.

j. Always install new liner packing rings and crevice seal when assembling liner to engine.

k. Under certain conditions, a cylinder block may be salvaged by removing a maximum of 0.010 inch of material from the top surface.

l. Use either a milling machine or large surface grinder. Locate block on main bearing pads, not on pad ledge.

m. Make light cuts (0.001 - 0.003 inch deep) removing only enough material to make block usable.

NOTE

Top of block must be parallel to main bearing bore.

o. Check distance from centerline of main bearing bore to top of reworked block. Find this dimension by placing block top down on a flat surface plate and measuring from main bearing bore to plate.

NOTE

Main bearing bore diameter, 4.749 - 4.750 inch and distance centerline of main bearing bore to top of cylinder block, 19.004 - 19.006 inches for an open block (18.994 - 18.996 inches for reworked block) must be held.

p. If counterbore ledge is worn unevenly from a fretting cylinder, clean up with a counterbore tool and adapter plate.

q. A correctly ground tool bit will leave a counterbore surface completely flat or cupped to a 30 minimum angle (the cupped surface is preferred) with a 0.005 - 0.015 inch radius. Refer to figure 2-106.

r. Turn tool in clockwise rotation with even pressure.

CAUTION

1. Never turn tool counterclockwise. Doing so will damage cutter blade.

2. Under no circumstances may inside diameter of ledge be lower than outside diameter. A ledge that droops toward center could contribute to cylinder liner breakage. Maximum counterbore depth after boring must not exceed 0.435 inch.

s. Chamfer edge of counterbore ledge 0.013 - 0.024 inch deep by 45 degrees after counterboring. (See figure 2-106) Do not Chamfer deeper than 0.024 inch to avoid reducing liner seating area.

t. Use shims to compensate for metal removed by wear or boring and to restore liner protrusion to 0.004 - 0.006 inch. For listing of shims available refer to table 2-10. Use a few shims as possible.

CAUTION

Do not extend cut full depth of counterbore or liner shims will not locate correctly.

u. Press fit cylinder liner oversize counterbore by enlarging the diameter to 6.144 - 6.146 inches with a vertical boring bar. Extend cut to 0.200 inch below surface of cylinder block. See figure 2-107.

NOTE

Remove all sharp edges and burrs.

v. Check cylinder head capscrew hole threads. If threads are damaged, block may be repaired by installing Helicoil or equivalent inserts.

w. Semifinished replacement main bearing caps are available for limited use in overhaul shops equipped to machine and install same.

x. The responsibility for use of semifinished caps must be assumed by engine owner or shop which performs the work.

y. Replace main bearing caps have 0.003 inch excess material in bore and 0.005 inch excess in length (pilot dimension), all other dimensions are same as finished main bearing caps. Process as instructed in steps z thru ac.

z. Machine an equal amount of material from each end of semifinished cap to give 0.002 - 0.004 inch interference fit in cylinder block.

aa. Ream main bearing bore.

CAUTION

Do not ream the main bearing bore indiscriminately. It should never be necessary to ream the main bearing bore unless a cap has been distorted or replaced.

Legend To Figure 2-105

1. Camshaft Bushing
2. Camshaft Bushing
3. Camshaft Bushing
4. Cover
5. Screw
6. Lockwasher
7. Gasket
8. Pin
9. Pin
10. Pin
11. Pin
12. Sleeve Bearing
13. Screw
14. Lockplate
15. Pin
16. Plug
17. Plug
18. Plug
19. Plug
20. Plug
21. Plug
22. Plug
23. Plug
24. Plug
25. Plug
26. Plug
27. Cylinder Liner
28. Packing
29. Cylinder Block

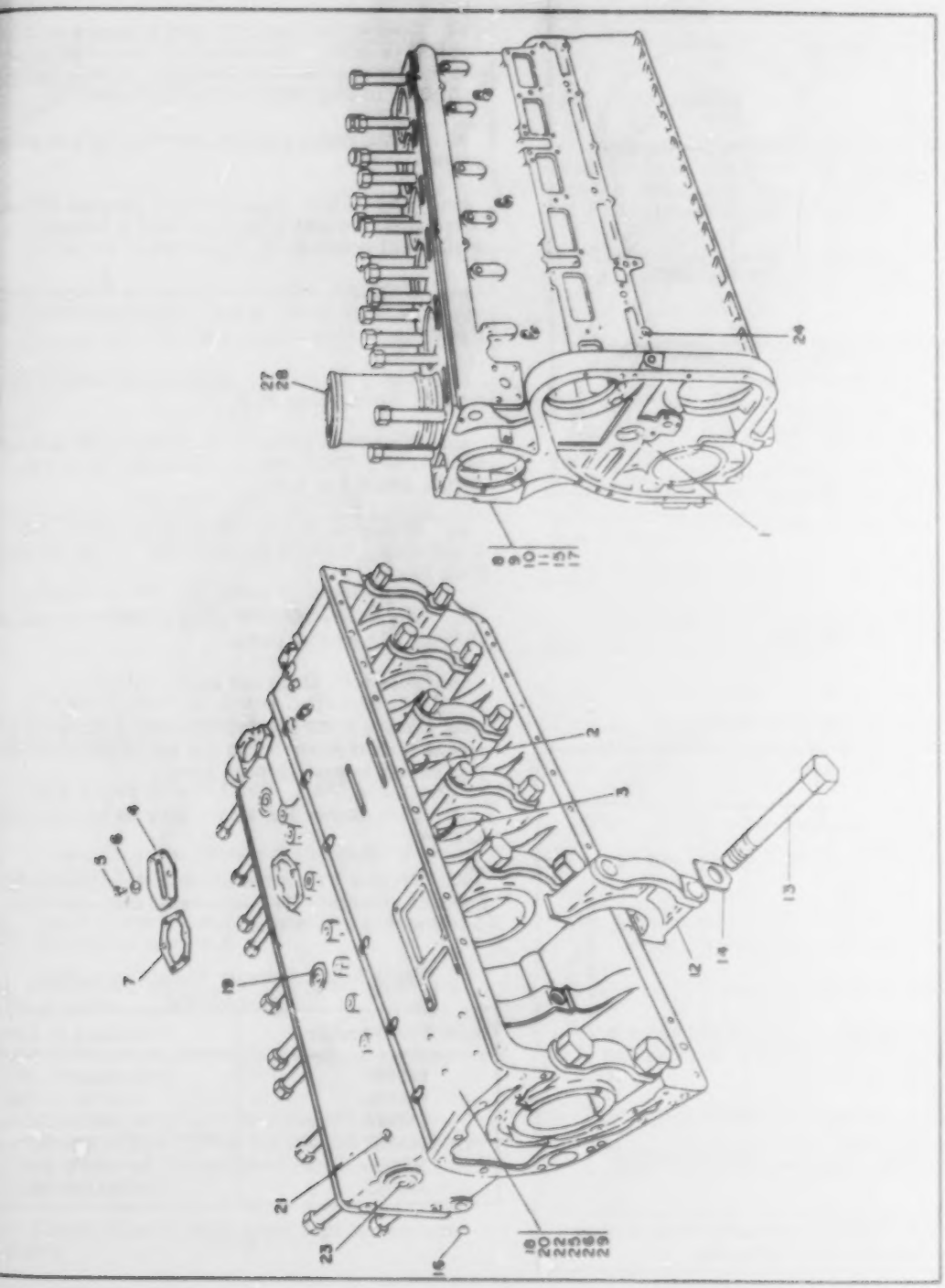


Figure 2-105. Cylinder Block Assembly

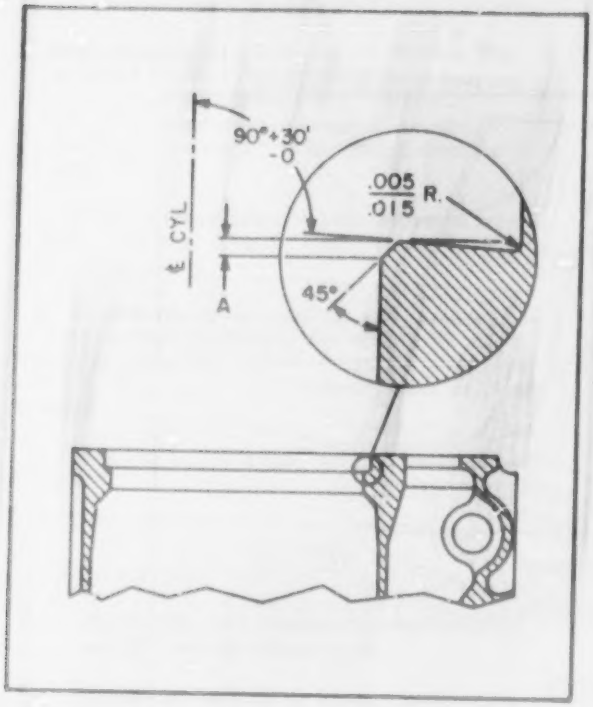


Figure 2-106. Cylinder Liner Counterbore Cross Section

ab. Remove by lapping or surface grinding 0.002 - 0.003 stock from bottom milled surface of units which are out of alignment.

NOTE

Omit step ac if replacement caps are being used.

ac. Lay reaming bar in block so rear end of bar is piloted in two good main bearing bores.

ad. Install all main bearing caps.

ae. Lubricate cutters of reamer and bores in block. This will prevent reaming oversize and will allow a better finish.

af. Use a hand driver to turn the reamer. The driver should be loosely pinned to prevent up and down or side thrust of reamer while it is being turned.

ag. Run reamer through remaining main bearing bores without backing up or reversing.

ah. Check alignment using a main bushing alignment fixture.

al. Ream out water holes as necessary.

aj. Use counterbore to lowered into 9.16 inch bushing in bushing plate until it bottoms on cylinder block.

ak. Operate tool and with light pressure on drill, cut hole to depth. The cutter will freewheel when stop collar reaches drive bushing. A little lubricant on bottom of stop collar will reduce wear.

al. Install water passage sleeve using a bushing driver.

am. Align sleeve in top of water passage hole and drive sleeve in with a hammer until it bottoms. Sleeve will protrude above surface of block.

an. If block is to be resurfaced, no further work has to be performed. If not, file bushing flush with top of block using a wide, flat mill file.

ao. Repair lower liner packing ring bore by proceeding through step aq to aaa.

ap. Bore block as shown in figure 2-108 bottom of block bore 5.936/5.938 inch diameter (8) to block deck 8.525/8.540 inch.

aq. 20 degree chamfer (4) in block bore 0.010 - 0.020 deep. Refer to figure 2-108. Clean all chips from block.

ar. Mix sealer of three parts glycerine to one part litharge to a smooth paste.

as. Wipe bore clean and apply sealer.

at. Sleeve is larger than top bore. Place OD of sleeve against top of bench and press out of round just enough to push through bore.

au. Turn sleeve in cylinder bore so OD chamfer is down.

av. Provide a driver which closely pilots sleeve and with clearance flats on outside diameter coat OD of sleeve with sealer.

Table 2-10. Cylinder Liner Counterbar Shim Listing

Shim Part Number	Thickness in Inches
143938	0.0063/0.007
143939	0.0072/0.0088
143946	0.0081/0.0099
143947	0.018/0.022
143948	0.028/0.034
143949	0.056/0.068

NOTE

Use a few shims as possible, i.e. use one thick shim in preference to two or more thin shims. Never use shims thinner than those listed.

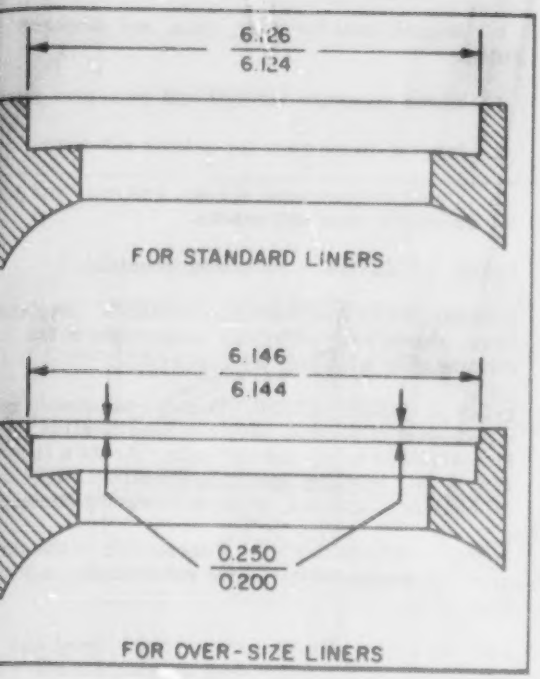


Figure 2-107. Oversize Cylinder Liner Counterbore Dimensions

Position driver and sleeve inchamfered edge re. Drive sleeve into bore of block with a heavy ner or hydraulic ram until it bottoms in bore.

Bore sleeve ID as follows. Refer to figure

Bottom of sleeve 20 degrees chamfer (5) block 7.314 - 7.326 inch.

Top of sleeve 20 degree chamfer to (4) block 7.125 inches maximum.

Sleeve bore diameter 5.749/5.751 inch (6) to th of 8.855 - 8.875 inch (7).

Remove boring bar and break sharp corners ine emery cloth.

Flush bore thoroughly to remove all emery nd boring chips. Blow dry with moisture-free ressed air and coat machine surfaces with e lubricating oil.

Check cylinder liner lower bore for correct nent.

A. LUBRICATION. No lubrication required.

REASSEMBLY. Reassemble in reverse of disassembly.

2-534. CHASSIS ASSEMBLY.

2-535. SPECIAL TOOLS. No special tools required.

2-536. DISASSEMBLY. Disassemble the chassis assembly in accordance with figure 2-109.

2-537. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe the surfaces with a clean, damp, lint free cloth. Dry with clean, filtered compressed air.

b. Clean all other metal parts with dry cleaning solvent, Federal Specification P-S-661.

CAUTION

Do not allow dry cleaning solvent, Federal Specification P-S-661 to come in contact with electrical parts.

2-538. INSPECTION. Inspect the members of the chassis for corrosion, rust, distortion, cracks, and other defects.

2-539. TESTING. No testing required.

2-540. REPAIR OR REPLACEMENT. Replace defective parts as required.

2-541. LUBRICATION. No lubrication required.

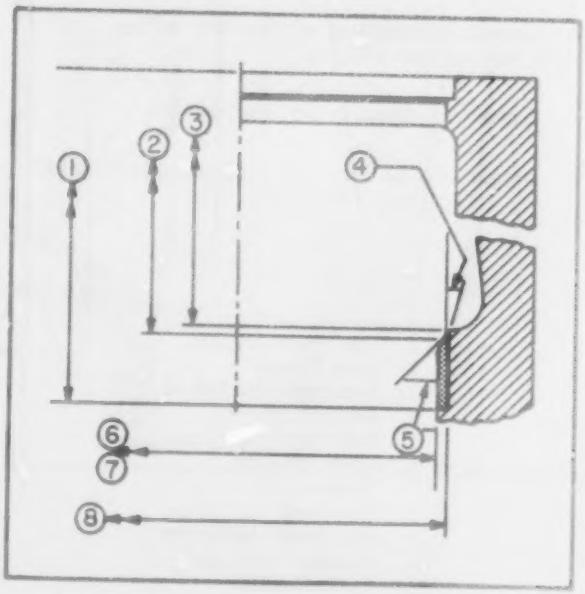


Figure 2-108. Sleeve and Block Boring Dimensions

2-542. REASSEMBLY. Reassemble in the reverse order of disassembly.

2-543. RUNNING GEAR ASSEMBLY.

2-544. SPECIAL TOOLS. No special tools required.

2-545. DISASSEMBLY. Disassemble the running gear assembly in accordance with figure 2-110.

2-546. CLEANING.

a. Wash painted surfaces with a mild soap and water solution. Rinse with clean water. Wipe surfaces with a clean, damp, lint free cloth.

b. Steam clean components of the axle assembly with a steam jet to remove heavy concentrations of grease and dirt.

c. Wash all remaining components except brake assembly in a bath of dry cleaning solvent, Federal Specification P-S-661.

d. Blow dirt out of brake assembly with clean, filtered, compressed air.

e. Dry all parts with clean, filtered, compressed air.

2-547. INSPECTION.

a. Inspect all parts for damage.

b. Inspect all mounting surfaces for scores, burrs, and similar defects.

c. Inspect oil passages for obstructions.

d. Inspect oil seals for cuts, cracks, and hardness.

e. Inspect tires for wear, cuts, and damaged rubber.

f. Check innertube for cuts and excessive patches.

g. Inspect clevis rods for cracks and wear.

h. Check compression spring, rod end, and pawl for excessive wear and cracks.

2-548. TESTING. No testing required.

2-548A. REPAIR OR REPLACEMENT. Replace worn, damaged or defective components of the running gear assembly as required.

2-549. LUBRICATION. During reassembly apply a light coat of grease, Military Specification MIL-G-10924 to the hub and axle. Apply a light coat of oil, Military Specification MIL-L-002105 to all bearings, sleeves, pins, and bearing surfaces.

2-550. REASSEMBLY. Reassemble in the reverse order of disassembly. After reassembly, adjust as follows:

a. To adjust wheel bearing, rotate wheel and tighten nut until a heavy drag is felt. Loosen nut to the next position where the cotter pin may be inserted. At this position, the wheel should rotate freely and there should be a barely perceptible feel of looseness when the hub is rocked up and down on the spindle. When making this adjustment with wheels installed, the brakes should not be dragging on the drum.

b. To adjust brake, mount brake on brake flange and mount hub and drum assembly on spindle. Remove spring clip covers over adjusters. Turn star wheels until shoes are in contact with drum. Back off each star wheel six notches (or clicks). Rotate the hub and drum assembly to assure that the brake is released. Back off an additional notch if drum does not turn freely. Install spring clip covers and adjusters.

Legend To Figure 2-109

1. Fuel Tank Support
2. Loop Clamp
3. Hex Head Cap Screw
4. Beveled Washer
5. Hex Head Cap Screw
6. Angle Bracket
7. Frame
8. Hex Head Cap Screw
9. Hex Head Cap Screw
10. U-Bolt
11. Angle Bracket
12. Lifting Frame
13. Hex Head Cap Screw
14. Hex Head Cap Screw
15. Lock Washer
16. Hsg. Frame
17. U-Bolt
18. Starter Solenoid Bracket
19. Cap and Chain Assembly
20. Tie Down Ring Assembly
21. Grounding Strap
22. Removable Channel Tine
23. Hex Head Cap Screw
24. Front Dust Pan
25. Center Dust Pan
26. Rear Dust Pan
27. Hex Head Cap Screw
28. Machine Screw
29. Skid

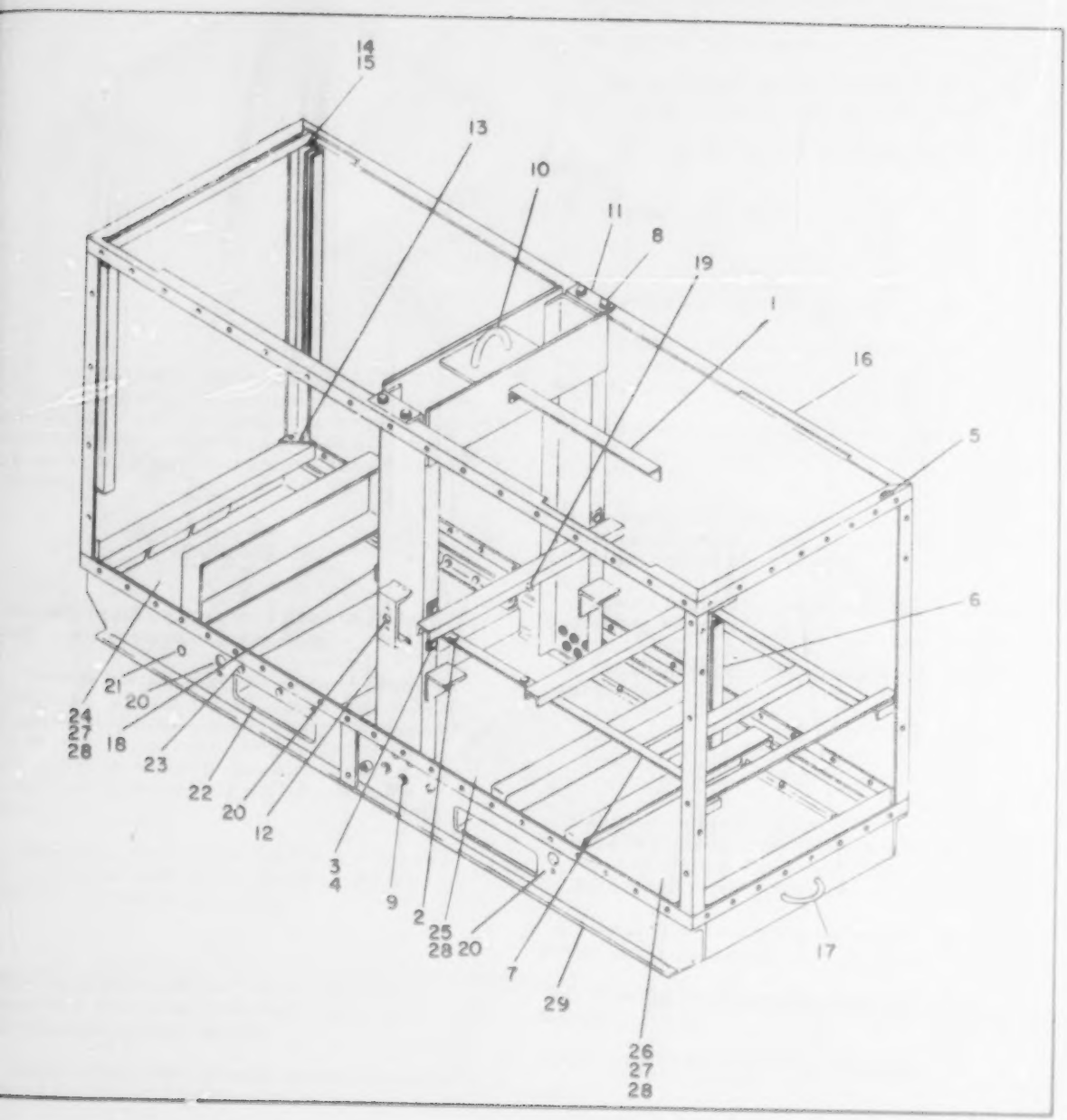


Figure 2-109. Chassis Assembly

51. REASSEMBLY OF MAJOR COMPONENTS. e reassembly of major components consists of the tallation of the major items removed from the rall assemblies noted in paragraph 2-3. Note following precautions and instructions during ssembly.

WARNING

Use proper lifting equipment when replacing engine and generator on skid base.

Prior to placing either the engine or generator skid base, engine flywheel counterbore must be l indicated to ensure concentricity and diameter 8.376 inch, maximum. Generator flexible pling disc must also be measured to ensure that maximum diameter does not exceed 18.374 hes.

Install two pilot bolts in the flywheel and two ot bolts in the bellhousing. Install bolts dia- trically opposed to each other.

NOTE

The use of pilot bolts will aid in aligning the generator drive plate holes and adapter with the flywheel and bell housing.

Make a final check to make certain all mating faces are free of foreign material.

Lift generator with hoist and position onto ine flywheel and bellhousing.

Install flywheel bolts and remove pilot bolts. hten bolts evenly.

CAUTION

Drive disks must fit completely flush onto flywheel. If disks do not fit completely into recess or if bolt holes become elongated or warped install a new set of drive disks. Never use damaged drive disks.

f. Bolt generator adapter to engine bellhousing. Remove pilot bolts. Tighten all bolts evenly.

g. Retighten all flywheel bolts and bellhousing bolts.

h. Tighten engine trunnion bolts.

NOTE

Remove temporary supports if used.

i. Be sure connections between load and reconnection panel and the generator are made in accordance with wiring diagram.

j. Replace components of the fuel system in accordance with the instructions provided during removal.

k. Always use a sufficient number of personnel and lifting equipment to reinstall radiator and shutter assembly, control box assembly, etc.

l. Install engine and control harness in accordance with wiring diagram.

m. Install sending units, priming and tubing and bond straps.

CAUTION

Use proper care in wiring. Check all wiring prior to connecting batteries or external power to system. Be sure batteries are installed with correct polarity.

n. Never start or operate the equipment before proper power-off circuit tests are made.

o. Never place unit outside without the muffler installed.

2-552. STARTER ABUTMENT RELAY.

2-553. SPECIAL TOOLS. No special tools required.

2-554. DISASSEMBLY. Disassemble the starter abutment relay by following the sequence of index numbers in figure 2-111.

2-555. CLEANING.

a. Remove surface dirt or dust by blowing with low pressure filtered compressed air.

b. Clean with soft bristle brush moistened with chlorothene N. U. Federal Specification O-T-620C.

c. Wipe with lint free cloth and air dry with filtered low pressure compressed air.

2-556. INSPECTION. Inspect electrical parts and wiring for signs of overheating and charred or frayed insulation.

2-557. TESTING. The following procedure covers testing of the starter abutment relay.

a. PREPARATION FOR TESTING.

1. Construct and connect a test circuit as shown in figure 2-112.

2. Connect test circuit to 24 VDC Power Supply capable of 1 ampere delivery.

3. Utilizing an oscilloscope set the controls as follows:

(a) Y-Axis; volts full scale - 10

(b) Mult. (Y-Axis) - 2.25

(c) X-Selector - 10 D. C.

(d) Amplitude - 55

(e) Sync. Selector - Ext.

(f) Sync. Amplitude - 0

(g) Sweep Vernier - full counter-clockwise

(h) Sweep Range - 2

b. TEST PROCEDURE.

1. Connect Y-Axis scope input across capacitor (plus to top terminal and minus to bottom terminal.

2. Jump top terminal of Y-Axis input to top terminal of X-Axis input.

3. Set dot on scope to lower left of screen.

4. Raise input voltage to test set to 24V D. C. - light on test circuit should illuminate.

5. Close switch in test circuit.

6. Scope should trace line to upper right corner of screen, and test light should go out.

7. If scope does not trace a definite line, but abruptly appears in upper right corner, unit is defective.

8. If test lamp does not go out, upon pushing test unit is defective.

9. End of test.

2-558. REPAIR OR REPLACEMENT. Refer to schematic figure (A). Check individual components for proper value. Check wiring repair or replace as necessary.

2-559. LUBRICATION. No lubrication required.

2-560. REASSEMBLY. Reassemble in the reverse order of disassembly.

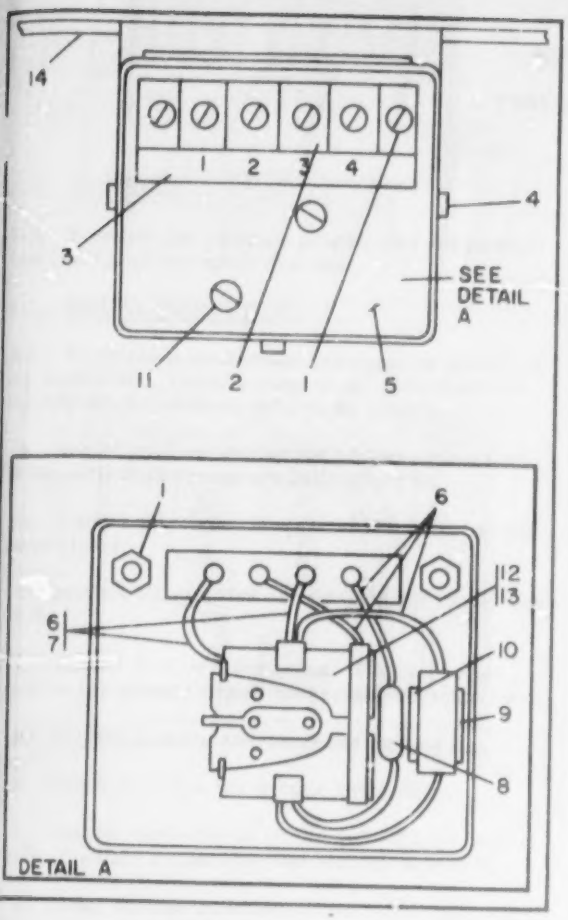


Figure 2-111. Starter Abutment Relay

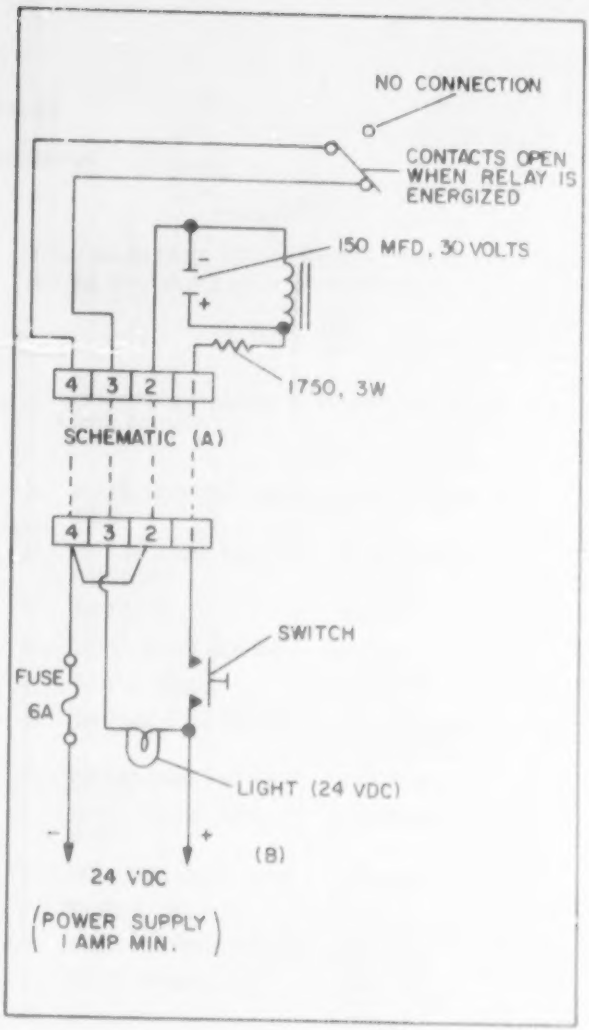


Figure 2-112. Starter Abutment Relay and Test Circuit Schematic

1. Screw, washer, nut
2. Terminal Board
3. Marker
4. Screw
5. Cover
6. Wire
7. Tubing
8. Resistor
9. Clamp
10. Capacitor
11. Screw
12. Tape
13. Relay
14. Box

SECTION III

TEST PROCEDURE

3-1. GENERAL.

3-2. This section contains procedures designed to test the equipment after overhaul.

3-3. VISUAL INSPECTION.

3-4. Subsequent to overhaul but prior to operating the equipment, visually inspect all components of the system for obvious defects as follows:

a. Inspect battery cables for proper connection. Make certain batteries are fully charged.

b. Inspect all wiring for proper routing and tight connections.

c. Inspect all mounted components for loose hardware.

d. Inspect fuel tank for leaks. Check coolant system for leaks. Check crankcase lubricant level.

e. Inspect louvers and doors for proper fit.

f. Check switches for proper connection.

g. Inspect mounting of intake and exhaust manifolds, flexible connection and muffler assembly.

h. Make certain GAIN and STABILITY adjustment locking nuts on the governor control unit are tight. Tighten to a torque of 8 to 10 lb.-in.

i. Move the throttle or actuator lever manually and check for a binding condition. If a binding condition is present, it must be eliminated.

j. Keep magnetic pickup leads away from alternator output leads, otherwise hunting or surging may occur.

k. Always braid (twist) magnetic pickup leads for their entire length before connecting them to the control unit harness plug.

NOTE

Examine unit identification plate for data relative to previous installation of authorized equipment changes on this specific generator set. After completion of unit overhaul tests, mark appropriate identification plate in accordance with official Technical Order and local depot, command, operating procedures. Similar action should be employed on major subassemblies by overhaul facility management.

3-5. PRESTART PROCEDURES. Perform the following procedures prior to operation of unit.

WARNING

Generator set should be grounded to avoid shock hazard.

A.	MANUAL VOLTAGE REG	FULLY CCW
B.	AUTOMATIC VOLTAGE REG	FULLY CCW
C.	AUTO-MAN	MAN
D.	LOAD CONTACTOR	OFF
E.	FREQ. ADJ.	CENTER
F.	PARALLEL SWITCH	SINGLE UNIT OPERATION
G.	OVERLOAD RESET	DEPRESS
H.	BAT. CHGR. CKT. BKR	DEPRESS
I.	DC. SYS. CKT. BKR	DEPRESS
J.	ELECT. HTR.	OFF
K.	FUEL BRNG. HTR	OFF
L.	FUEL PUMPS	OFF
M.	STARTER DISC	NORMAL
N.	VOLT. FREQ. CONTROL SW.	LOCAL
O.	BAT. CHGR.	OFF
P.	START AND OPERATE	STOP
Q.	TROUBLE LT. CKT. BKR	DEPRESS
R.	SAFETY RESET	DEPRESS
S.	SAFETY BYP	EMER. OPER. ONLY
T.	AM-VM SEL SW.	L1 - L2, PH1
U.	UNIT FUEL TANK DRAIN VALVE	OFF
V.	UNIT FUEL TANK SHUTOFF VALVE	ON
W.	ENGINE CRANKCASE	FILL, PROPER GR. OIL (MIL-L-2104)

X.	FUEL TANK	FULL, JP-4 (MIL-F-5624) OR DIESEL FUEL PROPER GR (VV-F-800)
Y.	AIR CLEANER OIL CUP	FILL, SAME OIL AS CRANKCASE
Z.	COOLING SYSTEM	FILL, WATER AND ETHYLENE-CLYCOL BY ATMOSPHERIC CONDITIONS.
AA.	VOLTAGE CHANGE-OVER BD	120/208 OR 240/416
AB.	BATTERIES	FILL WITH ELECTROLYTE AND CONNECT (SEE WIRING DIAGRAM)
AC.	GROUND TERMINAL	CONNECT TO GROUND
AD.	LOAD CONNECTION	CONNECT LOAD CABLE TO CORRESPONDING LOAD CONNECTIONS ON 60 HZ POSITION
AE.	50/60 HZ SW	60 HZ POSITION
AF.	HEATER AIR VALVE	ENGINE POSITION

3-6. PRIMING PROCEDURES. If the engine-generator set is to be operated for the first time, after a long period of idleness, or whenever the fuel flow between the set tank and the fuel injection pump has been broken, the system must be primed. To prime the engine-generator set, proceed as follows:

a. Loosen but do not remove, hose connection at intake port of fuel injection pump.

b. Open valve under set tank until fuel flows in solid stream without any air bubbles. Use a suitable container to catch excess fuel.

c. Tighten hose connection at intake port of fuel injection pump.

d. Close valve under set tank.

3-7. TESTING.

3-8. PERFORMANCE TESTS.

a. Operate panel light switch and check panel lights.

b. Operate push-to-test fault indication lamps and check lamps.

c. Connect 120 vac commercial power to terminal block points TB2, 10 and TB2, 11.

d. Set electric heater switch to ON position and check operation of immersion and battery box heaters. (Jump thermostat if necessary).

e. Turn switch off and remove jumper if connected.

f. Turn heater air valve to HEATER position.

g. Check for heater air flow. Battery box valve should be fully closed at 90° F ±5°. Shut-off fuel burning heater, return valves to initial position, and remove jumper, if connected.

h. Check battery charging system and adjust current controlling resistors if necessary as follows:

1. Set battery charger switch to high charge rate and adjust resistor R3 for 4 to 5 amperes.

2. Set battery charger switch to low charge rate and adjust resistor R2 for 1 to 2 amperes.

i. Complete the starting procedure in accordance with step 3 of the operating instructions located on the inside of the control panel access door. Run engine for 3 minutes and then shut unit down as indicated in step 6 of the operating instructions.

j. Check unit for fuel, lube oil, and coolant system leaks.

3-9. TEST RUN UNDER LOAD.

a. Connect calibrated test meters to the control panel to test the operation of the generator and control panel meters. Connect the test ammeter and wattmeter in series with the current measuring circuit of one line. Connect the voltmeter and frequency meter in parallel with one line and neutral. (L - N)

CAUTION

Improper connection of these meters will result in damage to the meters and the current transformer in the generator set.

b. Lower and close side doors of unit.

c. Start and operate unit in accordance with operating instructions located on the control panel door. Operate unit under conditions specified in table 3-1.

CAUTION

If any evidence of malfunction occurs during this test shut down and troubleshoot in accordance with table 3-2.

Table 3-1. Test Run Under Load

Elapsed Time (Minutes)	Rated Load (Percent)
30	No Load
30	25
30	50
30	75
60	100
5	125
10	No Load

Table 3-2. Troubleshooting Chart

Trouble	Probable Cause	Remedy
Engine fails to start	Fuel tank empty.	Check and fill fuel tank if required.
	Incorrect grade of fuel.	Check grade of fuel. Drain fuel system and refill with correct grade of fuel, if required.
	Water in fuel system.	Drain fuel system and refill with correct grade of fuel.
	Air leaks in fuel lines.	Check for air leaks in fuel system and correct if required.
	Restricted fuel lines.	Check fuel lines for restriction.
	Plugged injector spray holes.	Check injector spray holes and clean if required.
	Injector inlet screen dirty.	Clean injector inlet screen.
	Fuel pump screen and magnetic dirty.	Clean screen and magnet.
	Fuel pump lever stuck in shut-off position.	Locate and correct cause of trouble.
	Fuel pump defective.	Replace fuel pump.
	Crankcase oil too heavy for weather conditions.	Use correct viscosity oil.
	Air Cleaner dirty.	Check and service air cleaner if required.
	Restricted air intake.	Check inlet air restriction and correct if required.
	Jumper not connected between terminal boards TB1-2 and TB1-4.	Check that jumper is connected between these two terminal boards.
	Batteries BT1 and BT2 weak, dead, or defective.	Check condition of each battery. If batteries are weak, dead, or defective, plug external 28 (or 24)-volt d-c source into receptacle J6, placarded POWER RECEPTACLE 28 VDC STARTING. Remove external d-c source after engine starts. If batteries are weak or dead, set BAT CHGR switch S19 to HIGH position to charge batteries. If external source is removed BAT CHGR switch must be in HIGH position to keep engine running.
	Loose battery cable connections.	Tighten all battery cable connections.
	D.C. SYS CKT BKR CB3 defective.	Check CB3 and replace if required.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Engine Fails to Start (Cont)	START AND OPERATE switch S28 defective.	Check MANUAL & LOCAL contacts of switch S28 and replace if required.
	Engine fuel shut-off solenoid L1 defective.	Solenoid L1 does not energize. Check and replace shut-off solenoid if required.
	STARTER DISC switch S31 defective.	Check NORMAL contacts of switch S31 and replace switch if required.
	Contacts of relay K4 dirty or pitted.	Check and replace relay if required.
	A contacts of speed sensing switch S1 dirty or pitted.	Check contacts and replace switch if required.
	Lube oil pressure switch S2 dirty or pitted.	Check switch S2 and replace switch if required.
	Relay K2 defective	Replace relay, if required.
	Starter motor B1 defective.	Replace starter motor.
	Coil contacts of relay K30 defective.	Check K30 and replace if necessary.
Engine fails to start. Actuator EG1-A does not move to full fuel position when power is applied.	Actuator EG1-A metering valve piston binding.	Replace valve.
	Defective actuator EG1-A windings.	Replace EG1-A.
	Defective control unit EG1-C.	Replace EG1-C
Engine fails to start. Actuator EG1-A moves to full fuel position when power is applied.	Low engine rail line pressure.	Adjust fuel pump throttle valve to full open position and lock.
	Actuator EG1-A drive arm incorrectly adjusted.	Readjust arm.
Engine fails to start from remote location.	Jumper between terminal boards TB1-2 and TB1-4 not removed.	Check that jumper between these two terminal boards is removed.
	START AND OPERATE switch S28 defective.	With remote start-stop control closed, check AUTO & REMOTE contacts of S28. Replaces S28 if required.
	Relay K2 defective	Replace relay if required.
	Remote crank timer control on transfer panel defective.	With remote crank timer control closed, check that continuity exists between terminal boards TB1-2 and TB1-4.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
After engine starts, starter motor B1 not deenergized.	Contacts of speed sensing switch S1 do not close.	Check contacts and replace S1 if required.
Engine hunts or surges.	Actuator EG1-A sticking.	
	Magnetic pickup EG1-P loose.	Reset pickup air gap and secure mounting hardware.
	Binding actuator EG1-S lever.	Clean actuator interior.
	Defective capacitor C21 or C22.	Check capacitors and replace if necessary.
When an engine fault occurs, appropriate fault indicator lamp does not light, and engine does not stop.	SAFETY RESET pushbuttor S9 defective.	Check switch S9 and replace if required.
	Jumper not connected between terminal boards TB1-5 and TB1-6.	Check that jumper is connected between these two terminal boards.
	Relay K4 defective.	Check relay K4 and replace if required.
	Engine fuel shut-off solenoid valve L1 stuck in open position.	Check valve and replace if required.
Engine stops due to low lube oil pressure. LOW LUBE OIL PRESS, indicator lamp DS4 lights.	Crankcase lube oil level low.	Check engine crankcase lube oil level with dipstick and add oil if necessary.
	Oil leaks in lube oil line.	Check for external leaks in lube oil system and correct if necessary.
	Restricted lube oil line.	Check lube oil lines for restriction.
Engine stops due to low lube oil pressure. LOW LUBE OIL PRESS, indicator lamp DS4 does not light.	Indicator lamp DS4 defective.	Depress pushbutton lamp DS4. If lamp does not light, replace lamp.
Lube oil pressure gage indicates low pressure but engine does not stop.	Lube oil gage M2 not grounded.	Ground gage.
	Relay K18 defective.	Check relay K18 and replace if required.
	Low lube oil pressure switch S8 stuck in open position.	Check switch S8 and replace if required.
	Relay K6 defective.	Check relay. Replace relay, if required.
	Relay K3 defective.	Check relay K3. Replace relay if required.
	Contacts of relay K9 dirty or pitted.	Check contacts and clean if required.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Engine stops due to engine overspeed. OVERSPEED indicator lamp DS2 lights.	Improper throttle setting.	Check throttle setting and adjust if required.
	Open circuit in electric governor magnetic pickup EG1-P leads.	Repair or replace lead.
	Magnetic pickup EG1-P leads shorted to each other.	Repair or replace leads.
	Magnetic pickup EG1-P lead from control unit grounded.	Repair or replace lead.
	Faulty coil in magnetic pickup EG1-P.	Replace magnetic pickup.
	Incorrect air gap between magnetic pickup EG1-P and gear teeth.	Reset air gap.
	Tip of magnetic pickup EG1-P damaged.	Replace magnetic pickup.
	Excessive fuel leakage through electric governor actuator EG1-A metering valve.	Replace actuator.
Engine stops due to overspeed. OVERSPEED indicator lamp DS2 does not light.	Indicator lamp DS2 defective.	Depress pushbutton lamp DS2. If lamp does not light, replace lamp.
Engine speed excessive as indicated by increased frequency (more than 60 Hz) on a-c frequency meter. Engine does not stop and OVERSPEED indicator lamp DS2 does not light.	Overspeed switch S7 stuck in open position.	Check switch S7 and replace if required.
	Relay K8 defective.	Check relay K8 and replace if required.
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 lights.	Insufficient coolant.	Check cooling system and fill with coolant if required.
	Coolant thermostat defective.	Check coolant thermostat and replace if required.
	Radiator shutters stuck closed.	Free radiator shutters for manual operation.
	Radiator shutter thermostat defective.	Check shutter thermostat and replace if defective.
	Damaged water hose.	Check water hose and replace if required.
	Fan belt not adjusted properly.	Check fan belt for required tension and adjust if required.
	Coating of calcium salts on inside of cooling system.	Clean cooling system.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 lights. (Cont)	Radiator core openings plugged with dirt.	Blow out with compressed air.
	Water pump not operating properly.	Check water pump and replace if required.
	Exhaust pipes restricted. Usually accompanied by a hissing sound in exhaust.	Clean pipes and remove restriction.
	Engine overloaded.	Check output load and reduce if required.
Engine stops due to high coolant temperature. COOLANT TEMP HIGH indicator lamp DS1 does not light.	Indicator lamp DS1 defective.	Depress pushbutton lamp DS1, if lamp does not light, replace lamp.
Coolant temperature high as indicated on coolant temperature gage. Engine does not stop and COOLANT TEMP HIGH indicator lamp DS1 does not light.	Thermal switch S6 stuck in open position.	Check switch S6 and replace if required.
	Relay K7 defective.	Check relay K7 and replace if required.
Engine stops due to low fuel pressure.	Fuel pump defective.	Replace fuel pump.
	Fuel pressure switch S17 does not open at required fuel pressure.	Check switch S17 and replace if required.
Engine does not stop due to low fuel pressure.	Fuel pressure switch S17 stuck in open position.	Check switch S17 and replace if required.
Undervoltage condition occurs. UNDER VOLT indicator lamp DS5 lights.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
Undervoltage condition occurs. UNDER VOLT indicator lamp DS5 does not light.	Indicator lamp DS5 defective.	Depress pushbutton lamp DS5. If lamp does not light, replace lamp.
	Voltage frequency monitor K13 defective.	Replace K13.
Overvoltage condition occurs. OVER VOLT indicator lamp DS6 lights.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
Overvoltage condition occurs. OVER VOLT indicator lamp DS6 does not light.	Indicator lamp DS6 defective.	Depress pushbutton lamp DS6. If lamp does not light, replace lamp.
	Voltage frequency monitor K13 defective.	Replace K13.
Overcurrent condition exists. OVER CURRENT indicator lamp DS3 does not light.	Indicator lamp DS3 defective.	Depress pushbutton lamp. If lamp does light, replace lamp.
	Current transformers T1, T2 or T3 defective.	Check transformers and replace if required.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Overcurrent condition exists. OVER CURRENT indicator lamp DS3 does not light. (Cont)	Kilowatt transducer D1 defective.	Check output excitation of kilowatt transducer at terminals S1, S2, and S3. If excitation is absent, replace kilowatt transducer D1.
	OVERLOAD RESET pushbutton relay K20 defective.	Check coils of relay K20 and replace relay if required.
	Relays K10, K26, or K27 defective.	Check relays and replace if required.
	Voltage frequency monitor K13 defective.	Check K13 and replace if required.
When a generator fault occurs, exciter field is not disconnected.	Relay K9 defective.	Check relay K9 and replace if required.
	OVERLOAD RESET pushbutton K20 does not open.	Check pushbutton K20 and replace pushbutton relay if required.
When an engine fault occurs, generator load is not disconnected.	Contacts of relay K6 do not open.	Replace relay K6 if required.
	Relay K3 defective.	Check relay K3 and replace if required.
Battery charging ammeter M4 fails to indicate presence of charging current.	Ammeter M4 defective.	Check ammeter M4 and replace if required.
	Battery charging transformer T6 defective.	Check transformer T6 and replace if required.
	Battery charging rectifier CR1 defective.	Check rectifier CR1 and replace if required.
	Variable resistors R2 or R3 defective.	Check R2 and R3 and replace if required.
	BAT CHGR switch S19 defective.	Check switch S19 and replace if required.
	Relay K24 defective.	Check relay K24. Replace relay if required.
	BAT CHGR CKT BKR CB1 defective.	Check CB1 and replace if required.
During standby operation, lube oil and coolant does not warm up or maintain temperature.	ELEC HTR switch S18 defective.	Check switch contacts S18-1 and replace switch if required.
	Thermal switch S21 defective.	Check switch S21 and replace if required.
	Immersion heaters HR1 and HR2 defective.	Replace immersion heaters.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
During standby operation, battery box does not warm up or maintain temperature.	ELEC HTR switch S18 defective.	Check switch contacts S18-2 and replace switch if required.
	Thermal switch S22 defective.	Check switch S22 and replace if required.
	Battery box strip heaters HR4 and HR5 defective.	Replace strip heaters.
During cold weather operation, battery box strip heaters are inoperative.	Relay K4 defective.	Replace relay if required.
OPERATION switch S20 set to SINGLE UNIT position, and LOAD CONTACTOR switch S16 set to ON position, LOAD TERM ENERGIZED indicator lamp DS10 does not light.	Indicator lamp DS10 defective.	Check lamp and replace if required.
	Relay K19 defective.	Check relay K19 and replace if required.
	Load contactor switch S16 defective.	Check switch S16 and replace if required.
	Relay K6 defective.	Replace relay if required.
	Relay K4 defective.	Replace relay if required.
120/208 VOLT CONN or 240/416 VOLT CONN indicator lamps DS13 or DS14 do not light during appropriate mode of operation.	Indicator lamps DS13 or DS14 defective.	Check lamps and replace if necessary.
	Link bars on reconnection panel not positioned properly.	Check positioning of link bars and reposition if required.
	Resistor R6 defective.	Check resistor R6 and replace if required.
SYNCHRONIZING indicator lamps DS11 and DS12 do not light or operate properly.	Indicator lamps DS11 or DS12 defective.	Check lamps and replace if required.
	Resistors R4 or R5 defective.	Check resistors R4 and R5 and replace if required.
	OPERATION switch S20 defective.	Check switch S20 and replace if required.
	Cross current transformer T4 defective.	Check transformer T4 and replace if required.
	FREQ SEL switch S30 defective.	Check switch contacts S30-2 and replace switch if required.
Poor automatic voltage regulation.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.
	Voltage regulation automatic rheostat R13 defective.	Check rheostat R13 and replace if defective.
Unstable automatic voltage regulation.	Voltage regulator subassembly VR1 defective.	Replace voltage regulator subassembly VR1.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Poor manual voltage regulation.	Voltage regulation manual transformer T7 defective.	Check transformer T7 and replace if required.
	Transformer rectifier voltage regulator subassembly A1 defective.	Check subassembly A1 and replace if required.
Lube oil pressure gage M2 does not indicate.	Oil pressure gage defective.	Check gage M2 and replace if required.
	Lube oil pressure sending unit E1 defective.	Check sending unit E1 and replace if required.
	Gage not grounded.	Ground if necessary (case).
Fuel level gage M3 does not indicate.	Fuel level gage defective.	Check gage M3 and replace if required.
	Gage not grounded.	Ground if necessary (case).
	Fuel level sending unit E2 defective.	Check sending unit E2 and replace if required.
	Fuel level sending unit E2 defective.	Check sending unit E2 and replace if required.
AUX FUEL PUMP switch S27 placed in ON position, auxiliary fuel pump B4 or B5 does not operate.	FUEL BRNG HTR switch S13 not in OFF position.	Place switch S13 to OFF position.
	Auxiliary fuel pump B4 or B5 defective.	Replace defective auxiliary fuel pump.
Fuel burning heater HR3 fails to operate.	FUEL BRNG HTR switch S13 defective.	Check switch S13 and replace if required.
	Heater fuel shut-off solenoid valve L2 does not open when energized.	Open heater shut-off valve.
	A contacts of relay K6 dirty or pitted.	Check contacts and clean if required.
Fuel burning heater HR3 fails to operate.	Fuel burning heater thermal switch S24 dirty.	Check switch S14 and replace if required.
	Electric fuel pump B3 defective.	Replace fuel pump.
	Burned out igniter.	Replace igniter.
	Burned out preheat resistor.	Replace preheat resistor.
	Defective fuel control valve.	Replace fuel control valve.
	Overheat switch defective.	Replace overheat switch.
	Flame detector switch defective.	Replace flame detector switch.
Heater overheats and stops burning.	Restriction in vent air flow. Defective fuel control valve.	Remove restriction. Replace fuel control valve.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Heater overheats but continues to burn.	Defective overheat switch in conjunction with other defect which causes overheating.	Replace overheat switch and then determine other cause of malfunctioning.
Heat output too low.	Defective fuel control valve. Low fuel pressure.	Replace fuel control valve. Correct condition in fuel system.
Heater smokes excessively or "bangs" upon starting.	Leaking fuel control valve.	Replace fuel control valve.
Blower will not stop when heater is turned off (after approximately 5 minutes).	Defective flame detector switch.	Replace flame detector switch.
Odor of fuel in ventuating air stream.	Leaking fuel connection at standpipe or fuel control valve.	Tighten fuel connection.
Blower runs but heater fails to ignite at low ambient temperature.	Defective heating element in fuel control valve. Defective igniter. Defective preheat resistor. Low voltage.	Replace fuel control valve. Replace igniter. Replace resistor. Check for 24 volts d-c at terminals 3 and 8 of heater.
Heat exchanger becomes loaded up with soot and carbon when operating on diesel fuels.	Slow blower motor. High fuel rate. Restriction in exhaust. Too heavy grade of fuel for ambient condition.	Replace blower motor. Adjust fuel control valve. Remove restriction. Use correct grade of fuel. Clean heater by burning on gasoline.
Alternator temperature is extremely high.	Overload on alternator.	Check alternator terminal voltage and current and reduce alternator load, if required.
	Restricted alternator ventilation.	Check for obstruction in air intake and discharge openings and remove if present.
	Short, ground, or open circuit in alternator windings.	Check alternator windings. If defective, replace alternator.
Alternator shaft does not turn freely.	Rotor shaft bent.	Replace alternator.
	Rotor shaft bearing seized or worn.	Replace alternator.
Engine missing on all cylinders.	Incorrect grade of fuel.	Use correct grade of fuel.
	Water in fuel system.	Drain fuel system and refill with correct grade of fuel.
	Fuel injector nozzle valves sticking in body.	Clean fuel injectors.
	Leaking valves.	Regrind valves (overhaul level).
	Air cleaner dirty.	Check and service air cleaner if required.
	Valve clearance adjusted too close.	Readjust to correct clearance.
	Valve guides excessively worn.	Replace valve guides (overhaul level).

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Engine missing on all cylinders. (Cont)	Leaking head gasket.	Tighten cylinder head nuts to proper torque or replace gasket, if required.
	Warped or cracked cylinder head.	Replace cylinder head.
	Cracked cylinder block.	Replace diesel engine.
Engine misses on one or two cylinders.	Air leaks in fuel lines.	Check for air leaks in fuel system and correct if required.
	Restricted fuel lines.	Check for and remove restriction.
	Fuel injectors out of adjustment.	Check and adjust fuel injectors if required.
	Leaky valves.	Regrind valves (overhaul level).
	Valve clearance incorrect.	Adjust valves to proper clearance.
	Fuel injector nozzle valve sticking in body.	Clean fuel injectors.
	Piston rings and/or cylinder sleeves excessively worn.	Replace
	Valve spring or spring retainer lock broken.	Replace spring or lock if required.
Loss of power.	Restricted air intake.	Check for inlet air restriction.
	Exhaust pipes or muffler restricted.	Clean or replace exhaust system.
	Incorrect grade of fuel.	Use correct grade of fuel.
	Plugged injector spray holes.	Clean injector spray holes.
	Throttle linkage sticky.	Lubricate linkages and eliminate any binding.
	Air cleaner dirty.	Check and service air cleaner if required.
	Engine blow-by or leakage.	Check for engine blow-by. If blow-by is excessive, new rings, pistons, or lines are needed (overhaul level).
	Leaky valves.	Regrind valves.
	Incorrect valve and injection timing.	Check valve and injector timing and adjustment and readjust if required.
	Worn cylinder sleeves.	Replace.
	Piston ring, broken, stuck, or excessively worn.	Replace.
	Valves and/or valve seats pitted or worn.	Regrind valves and seats.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Increasing of black or brown smoke in exhaust.	Leaky head gasket.	Tighten cylinder head nuts to proper torque or replace gasket if necessary.
	Leaky valves.	Regrind valves.
	Incorrect grade of fuel.	Use correct grade of fuel.
	Dirty fuel injectors.	Clean fuel injectors.
	Worn piston rings.	Replace rings.
	Fuel injection timing too early, usually accompanied with pre-ignition.	Check fuel injection timing.
	Fuel injection timing too late, usually accompanied with loss of power but smooth and quiet running engine.	Check fuel injection timing.
Engine knocking.	Loose or worn main bearings.	Replace bearings.
	Loose or worn connecting rod bearings.	Replace bearings.
	Loose piston pins.	Replace pins.
	Worn pistons and cylinder liners.	Replace.
	Tighten piston pins.	Replace.
	Overheated engine.	Allow engine to cool and then determine cause of overheating.
	Lack of lubricating oil.	Fill crankcase with proper grade and quantity of oil.
	Loose flywheel.	Tighten in place. If worn excessively due to running loose, replace flywheel.
	Excessive end play in camshaft.	Adjust camshaft end thrust.
	Bent connecting rod.	Replace rod.
	Excessive valve clearance.	Adjust clearance to proper limits.
uel knocking.	Injector nozzle valve sticking due to dirt or corrosion.	Clean injectors.
	Injection nozzle spring broken.	Replace spring and close and readjust.
	Leaky cylinder head gasket.	Tighten cylinder head nuts to proper torque or replace gasket if necessary.
	Incorrect grade of fuel.	Use correct grade of fuel.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Fuel knocking. (Cont)	Insufficient coolant.	Check radiator level and fill with coolant if required.
	Engine overloaded.	Reduce load.
Intermittent fuel knocking in more than one cylinder.	Incorrect grade of fuel oil.	Use proper grade fuel.
	Injectors dirty or corroded.	Clean or replace as necessary.
	Water in fuel system.	Drain fuel system and refill with uncontaminated fuel.
Continuous and steady fuel knocking on all cylinders accompanied by dark smoky exhaust.	Incorrect grade of fuel.	Use proper grade of fuel.
Excessive fuel consumption accompanied by increased lubricating oil consumption due to oil dilution.	Sticking controls.	Lubricate linkages and eliminate any binding.
	Excessive idling of engine.	Do not idle engine for extended periods.
	Dirty air cleaner accompanied by loss of power.	Clean air cleaner.
	Engine overheating.	See engine overheating.
	Engine overcooling.	See engine overcooling.
Engine overheating.	Lack of cooling solution.	Refill cooling system and check for leakage.
	Fan belt not adjusted properly.	Check fan belt for required tension and adjust if required.
	Thermostat sticking.	Replace thermostat.
	Coating of calcium salts on inside of cooling system.	Clean cooling system.
	Dirt in radiator air passages.	Blow out with compressed air.
	Hoses deteriorated.	Replace hoses.
	Water pump not operating properly.	Replace pump.
	Exhaust pipes restricted. Usually accompanied by a hissing sound in the exhaust.	Clean pipes and remove restriction.
Engine overcooling.	Thermostat sticking open.	Replace thermostat.
Loss of coolant.	Leaks in radiator core.	Repair or replace as necessary.
	Loose hose connections.	Tighten connections.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Loss of coolant. (Cont)	Radiator tubes clogged.	Clean or replace radiator.
	Water pump seals defective.	Replace.
	Loose freeze plugs in block.	Tighten or replace plugs.
	Cracked cylinder head or block.	Replace diesel engine.
	Blown cylinder head gasket.	Replace gasket.
Excessive lube oil consumption.	Oil leaks at gaskets and parting surfaces.	Tighten or replace as necessary.
	Inferior grade of oil.	Use oil conforming to specifications.
	Ring gaps too large.	Replace.
	Worn or broken piston rings.	Replace.
	Cylinder sleeves out of round or worn.	Replace.
	Main or connecting rod bearing worn.	Replace.
	Oil rings clogged.	Replace.
	Dirty air cleaner.	Check air cleaner and service if required.
	Engine blow-by or leakage.	Check for engine blow-by. If blow-by is excessive, new rings, pistons, or liners are needed.
Bearing failures.	Continuous engine overspeeding.	Operate at governed speed.
	Lack of lubrication.	Keep oil at "H" mark on gage.
	Inferior grade of oil.	Use oil conforming to specification.
	Bent connecting rod.	Replace.
	Crankshaft rough or out of round.	Replace.
	Restricted oil passages.	Clean oil lines and passages.
	Bearing loose.	Replace.
	Dirty oil.	Service filter elements regularly.
Rapid cylinder or piston wear.	Breather and air cleaner not properly serviced.	Clean breather and air cleaner regularly.
	Inferior grade of oil.	Use oil conforming to specification.

Table 3-2. Troubleshooting Chart (Continued)

Trouble	Probable Cause	Remedy
Rapid cylinder or piston wear. (Cont)	Lack of lubrication.	Keep oil at "H" mark on gage.
	Dirty oil.	Service filter elements regularly.
	Piston rings not fitted properly.	Replace.
	Cold operation of engine.	Check thermostat and replace if necessary.
Valve sticking.	Incorrect valve clearance.	Adjust clearance.
	Valve springs weak or broken.	Replace springs.
	Valve stems or guides scored or dirty.	Clean, polish, or replace valves.
Burned valves or valve seats.	Valve clearance set too close.	Adjust valves to proper clearance.
	Weak valve springs.	Replace springs.
	Excessive carbon deposites.	Remove carbon deposits.
	Camshaft not timed correctly.	Retime camshaft.

d. Compare test meters with control panel meters at 100% of rated load. Meters should agree within 5% of calibrated test meters.

e. Check thermostatically controlled shutters to determine if they function correctly.

3-10. 120/208 VOLTAGE TEST.

a. Connect links on load and reconnect panel to 120/208 VAC.

b. Start generator.

c. Check 120/208 voltage in both automatic and manual positions.

d. Shut down unit.

3-11. SYNCHRONIZING LIGHTS TEST.

CAUTION

Load Contactor must be OFF.

a. Jump L-1 and L-3.

b. Start Generator.

c. Place parallel switch in the parallel position.

d. Observe that the synchronizing lights glow.

e. Place parallel switch in the single unit position, synchronizing lights should go out.

f. Shut down unit.

g. Remove jumper on L-1 and L-3.

3-12. 50/60 HZ MONITOR TEST.

a. Start generator.

b. Set the 50/60 Hz switch to the 50 Hz position. Set the frequency to 50 Hz using the FREQ ADJ potentiometer.

c. Adjust voltage with VOLTAGE REGULATION control to 190 VAC phase to phase (L-L).

d. Compare the voltage and speed with master instrument.

e. 50 Hz Undervoltage Test.

1. Slowly lower the voltage to find the undervoltage trip point. Trip point should be between 94 and 99 VAC in 7 to 9 seconds, phase to neutral (L-N).

2. Reset the undervoltage fault and return the L-L voltage to 190 VAC.

f. 50 Hz Overvoltage Test.

1. Slowly raise the voltage to find the overvoltage trip point. Trip point should be between 130 and 135 VAC in 1 to 2 seconds, phase to neutral (L-N).

2. Reset the overvoltage fault and return the L voltage to 190 VAC.

. Underfrequency Test.

i. Adjust voltage to 190 VAC, phase to phase L).

2. Lower the frequency until underfrequency p point is found. Trip point should be between to 46 Hz.

3. Reset the underfrequency fault and return the quency to 50 Hz.

60 Hz Undervoltage Test.

i. Set 50/60 Hertz switch to 60 Hz position.

2. Adjust frequency to 60 Hertz and voltage to VAC, phase to phase (L-L).

i. Slowly lower the voltage until undervoltage point is found. Trip point should be between to 110 VAC in 7 to 9 seconds, phase to neutral N).

. Reset undervoltage fault and return the L-L age to 208 VAC.

60 Hz Overvoltage Test.

. Slowly raise the voltage to find the overvolt- trip point. Trip point should be between 140 to VAC in 1 to 2 seconds, phase to neutral (L-N).

. Reset the overvoltage fault and return the voltage to 208 VAC.

. PROTECTIVE DEVICE TESTS.

. OVERSPEED TEST.

CAUTION

Do not exceed speed of 2250 RPM (75 Hz).

Simulate an overspeed condition by lifting rnor control rod to the raise position.

Trip point should be between 69 and 75 Hz. - 2250 RPM)

LOW OIL PRESSURE TEST.

With simulated air pressure, verify that the essure switch contacts close between 9 to 11

FUEL PRESSURE SWITCH TEST.

Simulate with air pressure that the fuel pres- switch contacts close at 35 PSI, plus or minus

3-17. HIGH WATER TEMPERATURE SWITCH TEST.

a. Remove thermal switch S6 from coolant thermostat and install temporary pipe plug.

b. Connect a thermocouple device to the thermal switch and place the thermocouple lead in an oil pot heated to 220°F.

c. Start and operate the engine at no load.

d. Thermal switch S6 should close and operate the high coolant temperature fault circuit. The switch should close at 220 degrees Fahrenheit, plus or minus 5 degrees.

3-18. VOLTAGE DROOP TEST.

a. Voltage droop is obtained by placing the OPERATION switch to the PARALLEL position and measuring the difference in voltage reading between rated voltage at full load (0.8 power factor) and voltage at no load.

b. At 100% of rated load, adjust cross-current resistor (R14) until a voltage droop of from 3% to 4% of rated voltage (L-L) is obtained. The value should be 12.48 vac to 16/64 vac for 416 operation and 6.24 vac to 8.32 vac for 120 to 208 vac connection.

3-19. VOLTAGE REGULATOR BANDWIDTH.

a. Check the voltage regulation variation during application of varying loads specified in Table 3-1.

b. Regulation variation should be equal to or less than 4% of rated voltage.

3-20. PHASE ROTATION TEST.

a. Connect an a-c phase sequence indicator (Associated Research, Inc. Model 40, or equivalent) to the corresponding phase connections at the output load terminals (L1, L2, L3) on the generator.

b. Connect the generator output for 240 - 416 volt operation.

c. Start the generator set.

d. Close the load contactor.

e. Determine the direction of phase rotation by observing the indicator.

f. Shut unit down and reconnect for 120-208 volt operation.

g. Repeat steps c, d, and e.

h. The phase rotation instrumentation reading should be A B C (clockwise).

3-21. PHASE BALANCE (VOLTAGE) READING.

a. Connect the generator output for 240 - 416 volt operation.

b. Connect an ac voltmeter with a 0-150/300 volt scale, and a frequency meter (115-230 volt, 40-70 Hz operation) to the generator set and operate the engine-generator set at rated speed (60 Hz) at no load, and with any one of the phase-to neutral voltages at rated value (240 volts).

c. Read and record all three voltages, and obtain the average value.

d. Reduce or raise, as required, any one of the three phase voltages by the amount that the computed average value differs from the rated voltage. The average of the three phase voltages should now be equal to the rated voltage.

e. Shut unit down and reconnect for 120-208 volt operation.

f. Repeat steps b through d.

g. The maximum difference in the three phase-to-neutral voltages should not exceed 1% of rated line-to-neutral voltage (208 or 416 volts).

3-22. ELECTRIC GOVERNOR ON ENGINE ADJUSTMENTS.

NOTE

The VIC (Speed Signal Frequency) setting for this unit is 2950 Hz for 50 Hz operation and 3540 Hz for 60 Hz operation. This is based on an engine governed speed of 1500 rpm for 50 Hz and 1800 rpm for 60 Hz and an engine ring gear containing 118 teeth.

a. Set SINGLE PARALLEL switch to SINGLE position.

b. Connect a 50 ohm, 2 ampere rheostat (Ohmite Model L, Type 0534 or equivalent) between control unit harness plug pin K and actuator harness plug pin D. Connect so that rheostat has decreasing resistance when the knob is turned clockwise.

NOTE

The rheostat is used to control actuator current, which in turn controls prime mover fuel, to prevent excessive overspeed should the control unit be improperly calibrated.

c. Set the rheostat to midrange.

d. Set variable frequency adjustment to midrange.

e. Loosen the GAIN and STABILITY locking nuts.

f. Turn GAIN full counterclockwise and back off (clockwise) approximately 75°

g. Turn STABILITY to midrange.

CAUTION

When starting an engine and until it comes up to speed, always be in position to quickly control fuel with the rheostat installed in step b.

h. Start and operate the generator set with no load. If the engine will not start with the rheostat knob in the middle of its range of travel, turn know slowly clockwise to increase fuel as the engine is cranked. Once the engine starts, immediately turn the rheostat knob back (counterclockwise) to mid range.

i. Normally, with the rheostat at midrange, the engine speed will be below the required operating speed.

j. Should the engine operation become unstable, stabilize it by turning the control unit STABILITY adjustment as follows:

1. Clockwise to overcome short, quick oscillations.

2. Counterclockwise to overcome long, slow oscillations (rolling).

k. Increase the engine speed until the governor takes control by turning rheostat knob clockwise. Should the engine become unstable as the knob is turned, alternately adjust the control unit STABILITY adjustment and rheostat until the governor has complete control of the engine.

l. Set the control unit GAIN adjustment counterclockwise. Should the engine become unstable as the GAIN is turned, restabilize with the STABILITY Adjustment. Repeat this procedure until the GAIN is as nearly counterclockwise as possible and the engine is stable.

NOTE

The best transient response will be obtained by keeping the STABILITY adjustment turned as far counterclockwise as possible while maintaining unit stability.

m. Should the governor system be controlling the engine at a speed more than 2 percent higher (approximately) than the required operating speed, adjust the VIC clockwise with a 5/64 inch Allen wrench, through the FREQ. ADJUST hole in the control unit cover, until the speed is approximately 2 percent higher than the required operating speed. Restabilize if necessary. If lowering the speed with the VIC causes the governor to lose control of the engine (the rheostat should take control) adjust the VIC slowly counterclockwise until the governor reestablishes control, then adjust the VIC counterclockwise an extra 1/4 turn. Turn the frequency potentiometer

counterclockwise to obtain the required operating speed.

n. Remove the rheostat that was installed in step b.

o. Should the governor system be controlling the engine at a speed lower than 2 percent (approximately) above the required operating speed, adjust the VIC counterclockwise with a 5/64 inch Allen wrench through the FREQ ADJUST hole in the control unit cover until the speed is approximately 2% higher than the required operating speed. Then adjust the frequency potentiometer counterclockwise to obtain the required operating speed. Restabilize if necessary.

p. Check the engine stability at half load, and then full load, and stabilize the engine at each load point, if necessary, by turning the control unit STABILITY adjustment. The engine must be stabilized at full load.

NOTE

If it is difficult or impossible to obtain satisfactory engine stability by following the procedure in step 1 connect a capacitor decade (Cornell-Dubilier Model CDE or equivalent) to control unit harness plug inserts "F" & "L" (insert "L" to the positive (+) terminal). Adjust the decade to 10 mfd capacitance and repeat the procedure in step 1. If the addition of the capacitance seems to minimize the instability, but does not eliminate it, add additional capacitance (in 10 mfd increments) by adjusting the decade and repeat the procedure in step 1 following each increase, until satisfactory stability is obtained. Once the amount of capacitance required to obtain stability is determined, remove the decade from the circuit and connect a high quality capacitor of same capacitance to control unit harness plug inserts "F" & "L" (insert "L" to the positive side of the capacitor). If more than one capacitor is used to obtain the required capacitance, the capacitors must be connected in parallel.

j. Retighten the control unit GAIN and STABILITY adjustment locking nuts to a torque of 8 - 10 lb.-in.

22A. PARALLEL OPERATION.

22B. STARTING. To start units in parallel operation, proceed as follows:

NOTE

No more than four units should be used in parallel operation. Any combination of 15, 30, and 60KW sets up to the including a total of four sets or any combination of 60-, 100-, and 150 KW sets up to and including a total of four sets.

a. Connect all units to a common load.

b. Observe the phase rotation (L1, L2, L3).

c. Connect ground terminals of all units to common ground.

d. Loosen locking nut and set governor GAIN control ccw full and then cw 1/4 turn. Retighten locking nut to a torque of 8 to 10 lb-in.

e. Start one unit and operate at full rated load.

NOTE

Should the prime mover be unstable, stabilize it by turning loosening STABILITY adjustment locking nut and turning the stability control clockwise to overcome short, quick prime mover oscillations; counterclockwise to overcome long, slow prime mover oscillations (rolling). Retighten the STABILITY adjustment locking nut to a torque of 8 to 10 lb-in.

f. Adjust unit speed with FREQUENCY ADJUST control R7.

g. Loosen locking nut and set stability control fully ccw and then to approximately 275 degrees cw. Retighten locking nut to a torque of 8 to 10 lb-in.

h. The governor system control frequency (VIC) is a factor that is normally established and set prior to installing a control unit. However, when a control unit failure occurs and an on-the-spot emergency replacement or adjustment is required, proceed as follows:

1. Turn the VIC full clockwise, then four full turns counterclockwise with a 5/64 inc allen wrench through the FREQUENCY ADJUST hole located in the control unit cover.

2. Set the frequency control R7 to mid-position.

3. Change the prime mover speed to the required operating speed by turning the VIC adjustment.

NOTE

Stabilize the unit if required by turning the STABILITY control clockwise to overcome short, quick prime mover oscillations; counterclockwise to overcome long, slow prime mover oscillations (rolling). It is desirable for parallel operation to have the electric governing system over damped, i.e. very stable, slow response.

i. Set OPERATION MODE switch to the PARALLEL position.

j. Set the voltage droop by adjusting R103 (inside control box) to obtain 4 volts droop (line to neutral voltage) from no-load to full load. Reactive load must be used for this adjustment. Adjust external load to 100% at 0.8 power factor.

NOTE

Use LOAD CONTACTOR switch to remove load. When removing the load, the unit load contactor must be utilized to avoid shut-down from the open phase detector (K114).

k. Short pin E to pin G of the J2 parallel plug.

NOTE

Jumper not supplied with equipment.

l. Adjust frequency droop adjust pot R8 to obtain a frequency droop (from No-Load to Full-Load) of 2 to 4% of rated frequency (8 Hz to 16 Hz). Resistive load may be used for this adjustment.

m. Shut down unit.

n. Repeat steps d. through m. for the other unit(s) as required. The voltage and frequency droop values should be set at the same values obtained on the first unit.

o. Connect the paralleling cable between the PARALLEL receptacles (J2 plug of one set to the J2 plug of the other sets) of the sets to be parallel.

p. Start one unit and operate at 20-100% of rated load.

NOTE

Make certain OPERATION MODE switch is in the PARALLEL position.

q. Start the second unit and observe the SYNCHRONIZING lights blinking on and off.

r. Adjust voltage on second set to be the same as on line unit.

s. Adjust FREQUENCY ADJUST control (R7) so the lights blink at a slow rate.

t. At the instant the SYNCHRONIZING lights are out, close the LOAD CONTACTOR switch (S102).

CAUTION

This must be accomplished the instant the lights go dark.

u. Adjust FREQUENCY ADJUST control (R7) until the unit kilowatt meters on all units read an equal value.

v. Adjust VOLTAGE ADJUST control (R101) until the ammeters on all sets read an equal value.

3-23. ACTUATOR ASSEMBLY (ADG100-1).

a. With the engine shutdown, move the plastic connecting link up and down by hand. The link should move from 0.005 in. to 0.010 in. If adjustment is necessary in order to obtain this movement, loosen the drive arm bolt, rotate the arm slightly on the actuator shaft, and retighten the bolt.

b. Adjust the P-T Throttle Valve to the full open position and lock it.

3-24. ACTUATOR LEVER AND THROTTLE LEVER.

a. Determine the total angular displacement of the engine throttle lever from the no fuel to the full fuel position.

b. Measure the distance between the centers of the throttle lever shaft and uniball joint holes in the throttle lever.

c. With the dimensions obtained in steps a and b, it is now possible to determine to which hole in the actuator lever the connecting link is to be connected. Use the following formulas:

$$\frac{\text{Throttle Lever Angular Displacement (See Step a)}}{\text{Working Portion of Actuator Angular Displacement (See Note)}} = \text{Required Lever Ratio}$$

$$\text{Throttle Lever Center Distance Dimension (See step b)} \times \text{Required Lever Ratio} = \text{Required Actuator Lever Center Distance Dim.}$$

NOTE

The actuator levers have approximately 15° angular displacement. The recommended working portion of this displacement is between 5 and 12 degrees or 7 degrees. When the required actuator lever center distance dimension is other than 2, 2.5, 3 or 3.5 inches, always utilize the next largest available center distance.

d. Should the required actuator lever center distance dimension exceed 3.5 inches, use the following formula.

$$\frac{\text{3.5 in.}}{\text{Required Lever Ratio}} = \text{Required Throttle Lever Center Distance Dim.}$$

Then, either obtain a new throttle lever with the required center distance dimension or drill a new hole in the existing throttle lever. The connecting link will be connected to the 3.5 inch hole in the actuator lever.

e. Both the actuator lever and throttle lever should be approximately perpendicular to the connecting link when the levers are midway through the working portion of their angular travel. In addition, the levers when viewed from above, must be aligned within 10 degrees.

f. With both the throttle and actuator levers in the fuel shutoff position, measure the distance between the lever Uniball holes and subtract 1-1/2 inches from the dimension obtained. The final dimension is the required connecting link length.

g. Either obtain or fabricate a connecting link of the required length. Actuator links require a 10-32 UNF-3A thread (1/2 in. minimum on both sides). Assemble appropriate nuts to the threads.

NOTE

Straight links are recommended.

h. Screw the connecting links approximately halfway into each Uniball joint.

i. Secure the linkage and Uniball assembly to the throttle lever.

NOTE

Throttle lever must be in the fuel shutoff portion.

j. Move the actuator lever approximately 5 degrees away from the fuel shut off portion and then secure the second Uniball joint to the proper hole in the operating lever.

NOTE

If adjustment is necessary to maintain the actuator lever in a position 3 to 5 degrees from the fuel shutoff position (with the throttle lever in the fuel shutoff position) adjust the Uniball joints on the connecting link. Throttle lever movement must not be limited by actuator lever stops.

k. Tighten the locknuts securely against the Uniball joints.

NOTE

Manually move the actuator lever to the full fuel position and release the lever. The lever and linkage assembly must snap back to the fuel shutoff position. Manually rotate the linkage assembly. The Uniball joints should swivel freely at least 10 degrees.

CAUTION

Any form of binding or excessive friction in the lever and linkage assembly will cause engine surge and instability.

3-25. TROUBLESHOOTING PROCEDURES.

3-26. The troubleshooting procedures given in table 3-2 are designed to isolate faulty components causing test failures. Refer to figures 3-2, 3-3, and 3-4 for schematic diagram, control box wiring diagrams, and unit wiring diagram respectively.

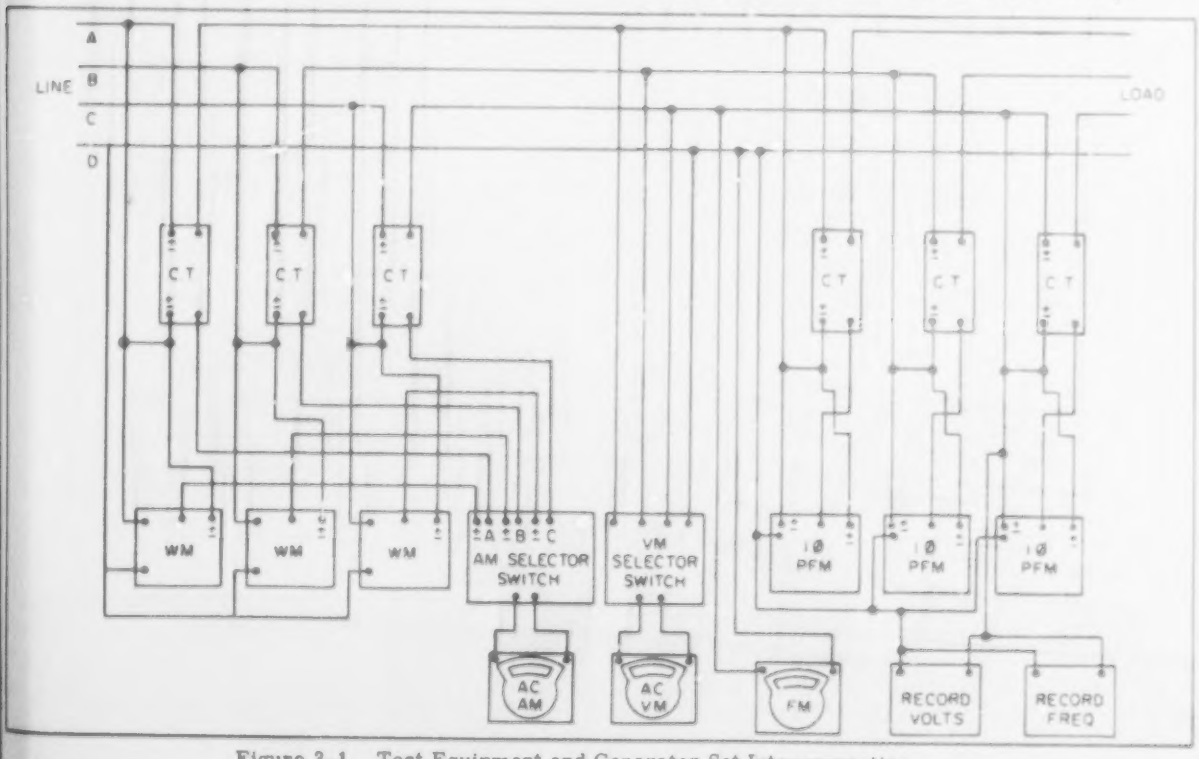


Figure 3-1. Test Equipment and Generator Set Interconnection

SECTION IV

DIFFERENCE DATA SHEETS

MB-16 GENERATOR SETS WITH G.E. ALTERNATORS

NOTE

These difference data sheets pertain only to MB-16 generator sets having General Electric alternators.

4-1. ALTERNATING CURRENT GENERATOR.

4-2. SPECIAL TOOLS. No special tools are required to overhaul the alternating current generator.

4-3. DISASSEMBLY. Disassemble the alternating current generator by following the sequence of index numbers in figure 2-25. Note the following:

a. Disconnect and label all exciter leads from leads entering generator shaft.

b. Disconnect and label exciter rotor leads from fan.

c. Disconnect and label regulator cable.

d. Use a bearing puller to remove bearing, exerting even pressure on the bearing race.

4-4. CLEANING.

a. Clean dirt and grease from interior and exterior components with a bristle brush that has been dipped in cleaning solvent, Federal Specification P-S-661.

b. Vacuum the stator and rotor windings to remove dirt, dust, and foreign matter.

CAUTION

Avoid using compressed air to clean the rotor and stator since this method may result in blowing metal chips and dirt into the insulation.

c. Remove old lubricant from lubrication fittings.

4-5. INSPECTION.

a. Inspect condition of windings, leads, and insulation. Examine for burned coils.

b. Be sure windings are secure in supporting slots. Check supporting ties by examining rigidity of coil end turns.

c. Check bearings, bushings, and coupling disk for excessive wear, scores, and burrs.

d. Examine surge protectors for signs of overheating, loose tape, and charred thyrites.

e. Check for bent or warped coupling discs.

f. Check rotor for loose insulating material and wires.

4-6. TESTING. Perform tests indicated in figure 2-26.

4-7. REPAIR OR REPLACEMENT.

4-8. GENERAL.

a. Repair broken or open leads to coils.

b. Replace burned or damaged coils and coils failing standards specified in figure 2-26.

c. Replace defective diodes and surge protectors.

d. If generator field is open or shorted, replace complete rotor assembly including shaft and coupling.

e. Replace generator bearing at each overhaul interval.

f. Replace damaged coupling disc.

4-9. GENERATOR REBUILD INFORMATION.

a. Generator Classification and Rating

Full load amperes	347/173.5
Rating (KVA) 125	125
Power Factor	0.8
RPM	1800
Voltage	208/416
Excitation Amperes	2.65
Excitation Volts	13.0
Duty Classification	Continuous
Degree of Enclosure	Dripproof - Protected
Cooling	Fan Action of Rotor
Drive	Engine
Lubrication	Grease per MIL-G-1092

b. Generator Stator

1.	Number of coils	- 60
2.	Coil span	- 10 (1-11)
3.	Dipping Temperature	- 170°C
4.	Baking time	- 4.5 hours
5.	Fungus treat	- none required

Step	Component under Test	Test Procedure	Value Required
1	Generator Stator	Test resistance of each coil	L-L High-voltage connections 0.061/0.055 ohms
2	Generator Field	Test resistance of each coil	L-L2. 11/1.90 ohms
3	Rectifier	Isolate each diode. Use multimeter with wide range ohmmeter. Place positive probe on fin of fan assembly and negative probe on terminal.	Infinite resistance
4		Reverse leads as given in previous step	Resistance should be 50 ohms or less.
5		Isolate each surge protector from circuit. Check resistance of each using several scales of meter.	Surge protector resistance should be between 85K and 150K
6	Generator Rotor	Test field resistance	Resistance should be 2.0 ohms.
7	Exciter Stator	Test field resistance	Resistance should be 4.67 ohms.
8	Generator Stator and Exciter Stator	Test resistance of insulation.	Minimum resistance to ground should be 1 MEGO.

Table 4-1. Electrical Tests of Generator Components

c. Generator Rotor

1. Number of coils	- 4
2. Turns per layer	- 184 turns per coil
3. Coil dimensions	- random wound, not pre-formed
4. Dipping Temperature	- 165°C
5. Baking time	- 11 hours
6. Fungus treat	- none required
7. Field resistance	- 2.11 ohms at 25°C

d. Exciter Stator

1. Number of coils	- 6
2. Turns per layer	- 180 turns per coil
3. Coil dimensions	- 4 1/4 in. long by 3 13/16 in. wide by 13/16 in. thick.
4. Dipping Temperature	- 165°C
5. Baking time	- 3 hours
6. Fungus treat	- none required
7. Field resistance	- 4.67 ohms at 25 percent

e. Exciter Rotor

1. Number of poles	- 6
2. Number of coils	- 36
3. Coil pitch	- 100 percent
4. Type of winding	- Distributed
5. Dipping Temperature	- 165°C
6. Baking time	- 4 hours
7. Fungus treat	- none required

4-10. GENERATOR REPAIR AND REPLACEMENT STANDARDS.

a. Generator Stator Standards

Number of Coils	60
Number of Slots	60
Coil Span	1-11
Turns Per Coil	4
Wires Per Coil	4 and 4
Wire Size	0.0571 and 0.0538 bare dia. Alkanex (B 22 M3) HYT
MLT	36.8 in.
Insulation Materials	
Topstick	Laminated Polyester sheet, glass mat base, standard Nema LPI Gr. GPO-60 pieces 9 in. long by 0.263 wide by 1/8 in. thick
Slot Tube	Dacron mat (0.005 in.) Mylar (0.005 in.) and Dacron mat (0.003 in.) laminated epoxy sheet, 70 percent saturated, 60 pieces 2 7/16 in. wide, 8 3/4 in. long
Separaior	Dacron mat (0.005 in.) Mylar (0.005 in.) and Dacron mat (0.003 in.) laminated epoxy sheet, 70 percent saturated, 60 pieces 11 in. In long by 11/32 in. wide

Phase Insulation	Insulating Material Dept., General Electric Co., Schenectady, Cat. No. 76522. 12 in. wide by 4 1/2 in. deep by 0.012 in. thick, 24 pieces - cloth and tape, glass, black varnish greasy finish.
Joint Insulation	Straight weave glass cloth treated with a yellow oleoresinous varnish, with a thermo-setting pressure sensitive adhesive on one side. Nominal thickness 0.0077 in. Nominal width 2 in. Approx. length 18 ft. Three thicknesses required.
Insulating Tubing	Approx 38 feet - Size No. 0 Braided fiber glass sleeving, oil varnish coating, 4000 volts dielectric breakdown. Industry Standard BBI
Cable Ties	Untreated tying cord, fiber glass, continuous filament. Nominal diameter 0.052 in. Breaking strength 176 lb min, approx 50 feet.
Dipping Compound	General Electric No. 9710 varnish
First Baking	Preheat stator 1 1/2 hours at 170°C
First Dipping	Submerge stator, connection end up, for 3 minutes. Drain 4 minutes. Rotate and drain 1 minute.
Second Baking	Bake in horizontal position at 170°C for 1 1/2 hours
Second Dipping	Same as first dipping
Third Baking	Same as second baking
Third Dipping	Same as first dipping
Fourth Baking	Same as second baking
Ground Test	1832 volts
Min. Insulation Resistance to ground	1 megohm

Exciter Stator Standards

Number of Coils	6
Number of Slots	6
Coil Span	1 Slot
Turns Per Coil	180
Wires Per Coil	3
Wire Size	0.0320 in. dia Heavy Formex

Insulation Materials

Slot Tube	Glazed, 100 percent rag paper (0.007 in.), polyester sheet (0.005 in.) laminations bonded with resinous type adhesive. 6 pieces 3 1/4 in. wide by 6 3/4 in. long creased to slot shape
Topstick	Textolite - cotton fabric phenolic laminate, heat treated. 6 pieces 3/32 in. thick, 3 1/4 in. long by 1.7500 in. wide
Phase Insulation	High dielectric, 100 percent rag insulating paper with glazed surface finish, laminated wet. 16 pieces 0.015 in. thick by 3 1/2 in. wide by 2 1/2 in. long
Insulating Tubing	Approx. 3 feet - Size No. 10. Braided fiber glass sleeving, oil varnish coating, 400 volt dielectric breakdown. Industry Standard BBI
Lacing String	Approx. 6 feet. Polished and waxed 12 ply cotton cord 0.0485 in diameter. 39 pound min breaking strength
Joint Insulation	Straight weave gloss cloth treated with a yellow oleoresinous varnish with a thermo-setting pressure sensitive adhesive on one side, Normal thickness 0.0077 in. Normal width 1 in. Approx length 2 feet
Dipping Compound	General Electric Co. No. 9710 Varnish
First Baking	Prehgat stator 1 hour 165° C
First Dipping	Submerge stator, leads up, 2 minutes. Drain 3 minutes. Rotate and drain 1 minute.
Second Baking	Bake, with leads horizontal 1 hour at 160°C
Second Dipping	Same as first dipping
Third Baking	Same as second baking
Third Dipping	Same as first dipping
Fourth Baking	Same as second baking
Ground Test	1500 volts
Min. Insulation Resistance to Ground	1 megohm

4-11. LUBRICATION. Pack new bearing with grease Military Specification MIL-G-10924 prior to reassembly. Pack grease cup with identical grease as required.

4-12. REASSEMBLY. Reassembly is the reverse of disassembly. Note the following:

a. Replace electrical leads as indicated by ta prepared at disassembly.

b. Press new bearing on shaft against shoulder, being careful to keep dirt or foreign matter ou the bearing.

APPENDIX A

REFERENCES

A-1. Fire Protection TB 5-4200-200-10	Hand Portable Extinguishers Approved for Army Users.
A-2. Lubrication LO 5-6115-574-12	Generator Set, Diesel Engine Driven: 100 KW, 0.8PF, AC, 120/208V-240/416V, 3 Phase, 60 Hertz, Convertible to 75 KW, 0.8PF, AC, 110/190V-220/380V, 50 Hertz, Skid Mounted (Fermont Model MB-16) w/Engine Cummins Model MH-220-BIG.
A-3. Radio Suppression TM 11-483	Radio Interference Suppression
A-4. Maintenance TM 38-750	The Army Maintenance Management Systems
A-5. Shipment and Storage TM 740-90-1	Administrative Storage of Equipment
A-6. Destruction to Prevent Enemy Use TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use.

APPENDIX B

Section I. MAINTENANCE ALLOCATION CHART

INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III lists the special tools and test equipment required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions, explanatory notes and/or illustrations required for a particular maintenance function.

B-2. EXPLANATION OF COLUMNS IN SECTION II.

a. Group Number, Column 1. The assembly group is a numerical group a assigned to each assembly in a top down breakdown sequence. The applicable assembly groups are listed on the MAC in disassembly sequence beginning with the first assembly removed in a top down disassembly sequence.

b. Assembly Group, Column 2. This column contains a brief description of the components of each assembly group.

c. Maintenance Functions, Column 3. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these functions. The symbol designations for the various maintenance categories are as follows:

C - Operator or crew
O - Organizational maintenance
F - Direct support maintenance
H - General support maintenance
D - Depot maintenance

The maintenance functions are defined as follows:

A - INSPECT. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

B - TEST. To verify serviceability and to detect electrical or mechanical failure by use of test equipment.

C - SERVICE. To clean, to preserve, to charge, to paint, and to add fuel, lubricants, cooling agents, and air.

D - ADJUST. To rectify to the extent necessary to bring into proper operating range.

E - ALIGN. To adjust specified variable elements of an item to bring to optimum performance.

F - CALIBRATE. To determine the corrections to be made in the readings of instruments of test equipment used in precise measurement. Consists of the comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

G - INSTALL. To set up for use in an operational environment such as an emplacement, site, or vehicle.

H - REPLACE. To replace unserviceable items with serviceable assemblies, subassemblies, or parts.

I - REPAIR. To restore an item to serviceable condition. This includes, but is not limited to, inspection, cleaning, preserving, adjusting, replacing, welding, riveting, and strengthening.

J - OVERHAUL. To restore an item to a completely serviceable condition as prescribed by maintenance serviceability standards using the Inspect and Repair Only as Necessary (IROAN) technique.

K - REBUILD. To restore an item to a standard as nearly as possible to original or new condition in appearance, performance, and life expectancy. This is accomplished through complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements (items) using original manufacturing tolerances and specifications, and subsequent reassembly of the item.

d. Tools and Equipment, Column 4. This column is provided for referencing by code the special tools and test equipment (Section III) required to perform the maintenance functions (Section II).

e. Remarks, Column 5. This column is provided for referencing by code the remarks (Section IV) pertinent to the maintenance functions.

B-3. EXPLANATION OF COLUMNS IN SECTION III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T&TE requirements column on the MAC. The letter represents the specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Category. This column shows the lowest level of Maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal Stock Number of tools and test equipment.

B-4. EXPLANATION OF COLUMNS IN SECTION IV.

a. Reference Code. This column consists of two letters separated by a dash, both of which are references to Section II. The first letter references column 5 and the second letter references a maintenance function, column 3, A through K.

b. Remarks. This column lists information pertinent to the maintenance function being performed, as indicated on the MAC, Section II.

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

100 KW Generator Set, DED, 60 Hz
Fermont Div of DCA, Model MB-16

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
1	BODY, CAB, HOOD & HULL ASSEMBLIES								O	F				1-A
	Doors & Hood	C							O	F				
	Panels	C							O	F				
	Housing	C							O	F				
2	EXHAUST SYSTEM													2-A
	Muffler & Pipes Exhaust Manifold Assembly & Muffler	C							O					
	Pipe, Exhaust	C							O					
3	MISCELLANEOUS BODY, CHASSIS OR HULL & ACCESSORY ITEMS													3-A
	Accessory Items			O					C					
	Hose, Auxiliary	C							O	F				
	Cable, Parallel	C	O											
4	AIR CLEANER								O	O				
	Cleaner Assembly, Air			C					O					
	Hose, Air Cleaner	C												

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
5	COOLING SYSTEM													
	Radiator													
	Radiator, Assembly		F	C					O	F	H			
	Cap, Radiator		O						O					
	Grill, Radiator			C					O					
	Shutter Assembly	C							O	O				4-A
	Control Assembly, Shutter		O		O				O	F				
6	TANKS, LINES FITTINGS													
	Tank, Fuel			C					O	O				
	Line, Injector	C							O					
	Line, Fuel	C							O					
7	CONTROL PANELS, HOUSING, CUBICLES													
	Control Box Subassembly	C							F	F				5-A
	Front Panel Assembly	C							F	F				
	Switches													
	Switch Rotary		O						O					
	Switch, Toggle		O						O					
	Meters	C	O				H		O					
	Converters	O	F						F					

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	Wiring Harness	O	F						●	F				
	Circuit Breakers													
	Circuit Breaker Assembly		F						F	H				
	Fuse & Fuse Holder	C	O						O					
	Regulator, Voltage													
	Regulator, Voltage		F		F				F	F	H	D		
	Resistors													
	Resistor, Variable		O		O				F					
	Rheostat, Voltage		O		O				F					
	Resistor, Fixed		O						F					
	Relay Assembly													
	Relay Assembly		O						F					
	Transformers; Rectifiers													
	Transformers		F						F					
	Rectifiers		F						F					
	Non Rotating Rectifiers, Converters, Inverts													
	Battery Charger Assembly		O						F	F	H	D		
	Master or Auxiliary Control Assembly													
	Unit Control, Governor	F	F		O				F	F	H	D		6-D
8	INSTRUMENTOR ENGINE CONTROL PANEL													
	Light Panel	C							O					
	Lamp	C							O					

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	Switch, Toggle	C							O					
	Wiring Harness	O	F						O					
	Meters, Electrical	O	F						O					
	Circuit Breaker		O						O					
	Gages, Mountings, Lines & Fittings													
	Gage, Fuel		O						O					
	Gage, Oil Pressure		O						O					
	Gage, Temperature		O						O					
9	FAN ASSEMBLY													
	Fan, Engine Cooling	O							O					
	Pulley & Hub Assembly	O		O					O					7-C
	Belt, Drive	C			C				O					
	Fuel Filters													
	Filter, Fuel			C					O					
	Strainer, Fuel			C					O					
	Engine Safety Controls													
	Switches, Safety		O						O					
	Governor, Overspeed		F				H		O	F	H			
	Starting Motor													
	Brushes	O							O					
	Starter, Engine, Electrical		F	O					O	F				
	Relay, Solenoid		O						O					

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	Radio Interference Suppression													
	Capacitors		O						O					
	Lead, Electrical	C							O					
	Strap, Ground	C							O					
	Accelerator, Throttle or Choke Controls													
	Control Assembly, Throttle	O			F				F					
	Fuel Pumps													
	Pump, Fuel Transfer	C		O					O	F				
	Pump, Fuel Injection	F	H		F		H		O	F	H	D		8-B
	Water Pump													
	Pump Assembly, Water	C		O					O	F	F	F		9-A, 10-C
	Engine Lubrication System													
	Filter Assembly, Oil	C		C					O	O				11-A
	Pump Assembly, Oil	F							F	F	F			
	Lines, Oil	C							O					
	Regulator, Pressure		F		F		F		F	F				
	Breather, Oil			C					C					
	Governor													
	Governor & Actuator	F	H	O	O				F	H	H	D		12-D
	Accessory Driving Mechanism													
	Accessory Pump Drive	F							F	H				
	Manifold													
	Manifold, Intake & Exhaust	C							O	F				13-A

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	Water Manifolds, Headers, Thermostats & Housing Gaskets													
	Thermostat		O						O					
	Hose, Pipe	C							O					
10	**ENGINE**													
	Engine Assembly													
	Engine, Diesel	C	O	C	O	F		F	F	F	H	D		14-B
	Flywheel													
	Flywheel Assembly	F				F			F	H				
	Crankcase, Cylinder Head													
	Crankcase	H							H	H	H	D		
	Head, Cylinder	F							F	F	H	D		15-J
	Liner, Cylinder	H							H					
	Fuel Injector													
	Injector Assembly	F	H						F	H	H	D		16-B
	Rod Assembly, Push	F							F					
	Gears, Timing	F			F	F			F					
	Valves, Camshafts, Timing System													
	Bearings, Camshaft					H			H					
	Valves, Exhaust & Intake	F			O				F	F				17-I
	Rocker, Arm Assembly	F			O				F	F				
	Camshaft	H							H					

SECTION II - MAINTENANCE ALLOCATION CHART

FOR

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	Crankshaft	H							H					
	Bearings	H							H	H		D		18-K
	Crankshaft	H							F					
	Seal, Front & Rear	F							F					
	Pistons, Connecting Rod													
	Rod Assembly	H						H	H					
	Piston Assembly	H						H	H	H				
	Bearing, Connecting Rod	H				H			H					
11	BATTERIES, STORAGE													
	Battery, Storage	C	O	C					O					19-A
	Cable Assembly	C							O	O				
12	ENGINE STARTING AIDS													
	Heater Assembly, Air	O		C					O	F				20-A
	Primer Assembly, Ether	O		C					O	O				
	Glow Plug, Crankcase	O		O					O					
	Strip Heater, Battery	O		O					O	O				
13	TERMINAL BLOCKS, JUNCTION BOXES													21-A
	Board, Terminal	C							O					22-H
	Panel, Reconnection	O		O	O				F	F				

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
14	GENERATOR ASSEMBLY													
	Generator Assembly	C	F	C					F	H	H	D		23-A
	Rotating Exciter Assembly	C	F	C					F	H	H	D		
	Drive Components Disc, Coupling	F				F			F					
	Ventilating System													
	Fan, Ventilating	H							H					
	Screens	C		C					O					
	Rotor Assembly													
	Rotor Generator		H						H	H	H	D		
	Rotor, Exciter		H						H	H	H	D		
	Stator Assembly													
	Stator, Generator		H						H	H	H	D		
	Stator, Exciter		H						H	H	H	D		
15	FRAME ASSEMBLY													
	Frame Base	C							F	F				25-A
	Stud, Ground	C							O					
	Eye, Lifting	C							O					
16	DATA PLATES													
	Plates, Data	C							O					
	Plates, Instruction	C							O					

SECTION III

MAINTENANCE ALLOCATION CHART

FOR: 100 KW Gen Set, DED, 60 Hz DATE: _____

Fermont Model MB-16 PAGE: 1 OF 1

SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	TOOL NUMBER
NOTE:		The exact type and quantity of tools and equipment required has not been fully resolved. Specific requirements will be determined at a later date.	

SECTION IV

MAINTENANCE ALLOCATION CHART

FOR: 100 KW Gen Set, DED, 60 Hz DATE

Fermont Model MB-16 PAGE 1 OF 1

REFERENCE CODE	REMARKS
1-A	Close Visual Examination
2-A	Close Visual Examination
3-A	Close Visual Examination
4-A	Close Visual Examination
5-A	Close Visual Examination
6-D	External Adjustment Only
7-C	Includes Packing Bearing with Grease
8-B	Includes Bench Test - Pressure
9-A	Close Visual Examination
10-C	Includes Packing Bearing with Grease
11-A	Close Visual Examination
12-D	External Adjustment Only
13-A	Close Visual Examination
14-B	Operational Test Only
15-J	Includes Refacing as Necessary
16-B	Includes Bench Test - Pressure Test
17-I	Includes Refacing Valves
18-K	Includes Metalizing and Machining to Standard
19-A	Close Visual Examination
20-A	Close Visual Examination
21-A	Close Visual Examination
22-H	Movable Change - Board Only
23-A	Close Visual Examination
24-A	Close Visual Examination
25-A	Close Visual Examination

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APPENDIX C

BASIC ISSUE ITEM LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED

Section I. INTRODUCTION

C-1. Scope

This appendix lists basic issue items, items troop installed or authorized which accompany the generator set, and are required by the crew/operator for operation, installation, or operator's maintenance.

C-2. General

This basic issue items, items troop installed or authorized list is divided into the following sections:

a. Basic Issue Items List - Section II. "Not Applicable."

b. Items Troop Installed or Authorized List - Section III. A list, in alphabetical sequence of items which at the descretion of the unit commander may accompany the end item, but are NOT subject to be turned in with the end item.

C-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items List, Section II, and Items Troop Installed or Authorized, Section III.

a. Source, Maintenance, and Recoverability Code(s)(SMR).

(1) Source code, indicates the source for the listed item. Source codes are:

Code	Explanation
P	Repair parts, special tools and test equipment supplied from GSA/DSA or Army supply system and authorized for use at indicated maintenance levels.
P2	Repair parts, special tools and test equipment which are procured and stocked for insurance purposes because the combat or military essentiality of the end item dictates that a minimum quantity be available in the supply system.

(2) Maintenance code, indicates the lowest level of maintenance authorized to install the listed item. The maintenance level code is:

Code	Explanation
C	Crew/Operator

(3) Recoverability code, indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are non-recoverable. Recoverability codes are:

Code	Explanation
R	Applied to repair parts (assemblies and components), special tools and test equipment which are considered economically reparable at direct and general support maintenance levels.
S	Repair parts, special tools, test equipment and assemblies which are economically reparable at DSU and GSU activities and which normally are furnished by supply on an exchange basis.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required.

d. Unit of Measure (U/M). A 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Furnished With Equipment (BIIL only). This column indicates the quantity of an item furnished with the equipment.

f. Quantity Authorized (Items Troop Installed or Authorized Only). This column indicates the quantity of the item authorized to be used with the equipment.

g. Illustration (BIIL only). This column is divided as follows:

(1) Figure number. Indicates the figure number of the illustration in which the item is shown.

(2) Item number. Indicates the callout number used to reference the item in the illustration.

SECTION III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST

(1) SMR CODE	(2) FEDERAL STOCK NUMBER	(3) DESCRIPTION REF NO. & MFR CODE USABLE ON CODE	(4) UNIT OF MEAS	(5) QTY AUTH
PC	7520-559-9618	CASE: Maintenance and Operational Manuals	EA	1
PC	4210-555-8837	EXTINGUISHER, FIRE: Monobromotrifluoromethane charged, hand, penetrating seal valve, stored pressure w/bracket 2.75	EA	1

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

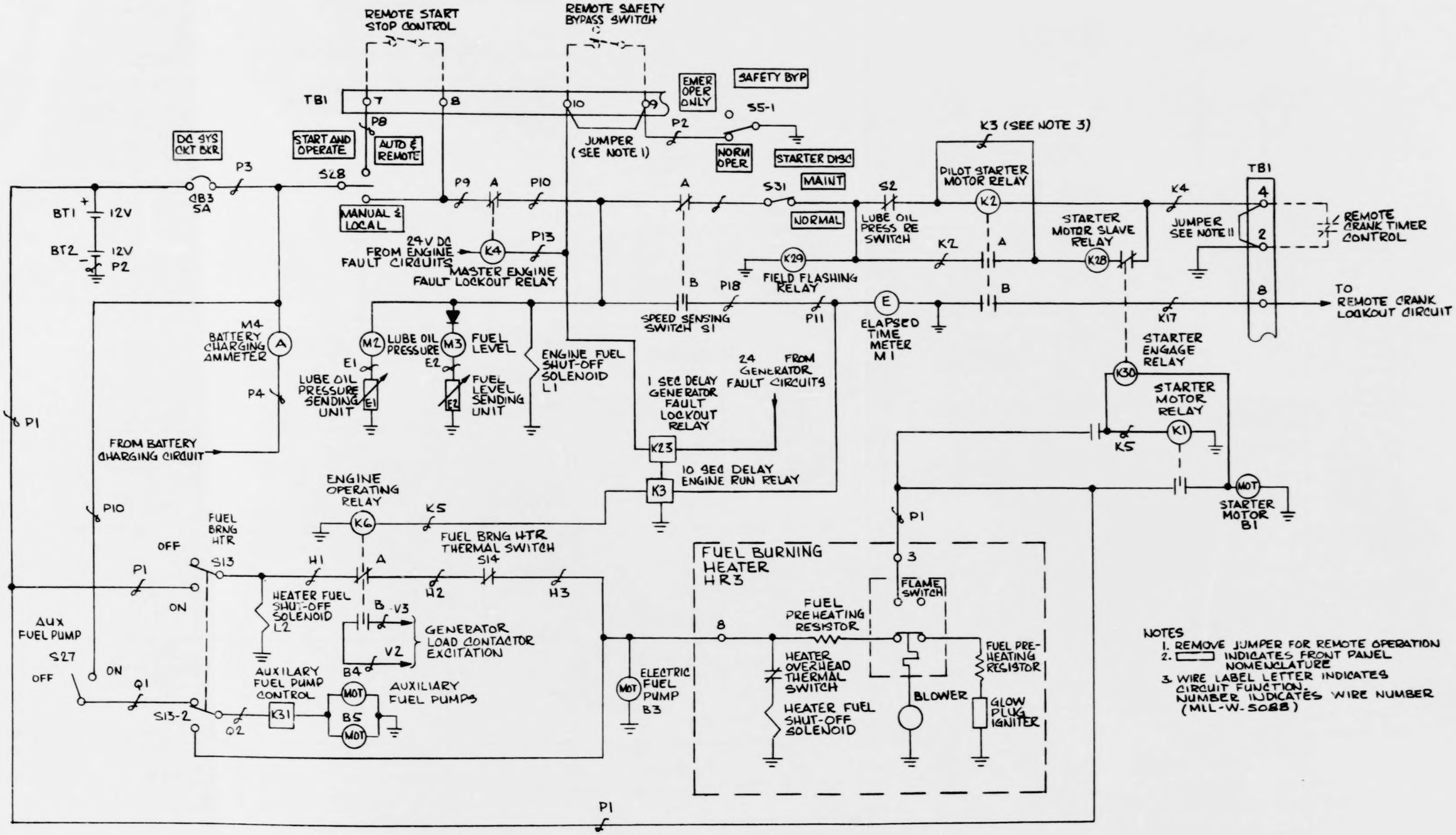
Official:

VERNE L. BOWERS,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-25D (qty rqr block No. 1066) Organizational Maintenance Requirements for Generator Sets, Engine Driven, 100 KW, 60HZ, Precise Power.

★ U.S. GOVERNMENT PRINTING OFFICE: 1969 242-451/05558



NOTES
1. REMOVE JUMPER FOR REMOTE OPERATION
2. ▭ INDICATES FRONT PANEL NOMENCLATURE
3. WIRE LABEL LETTER INDICATES CIRCUIT FUNCTION. NUMBER INDICATES WIRE NUMBER (MIL-W-5088)

Figure 1-11. Engine Starting Circuits, Simplified Schematic Diagram

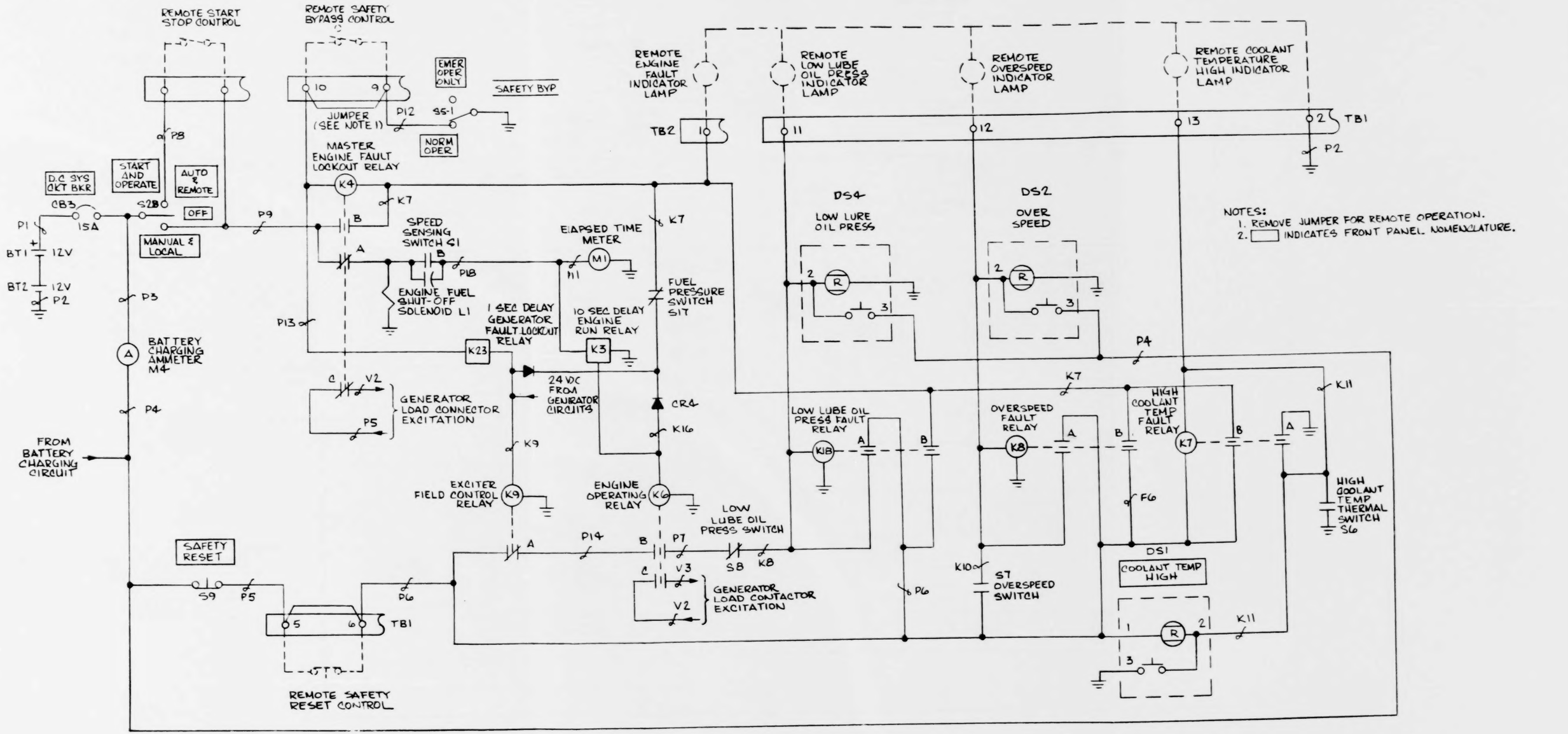
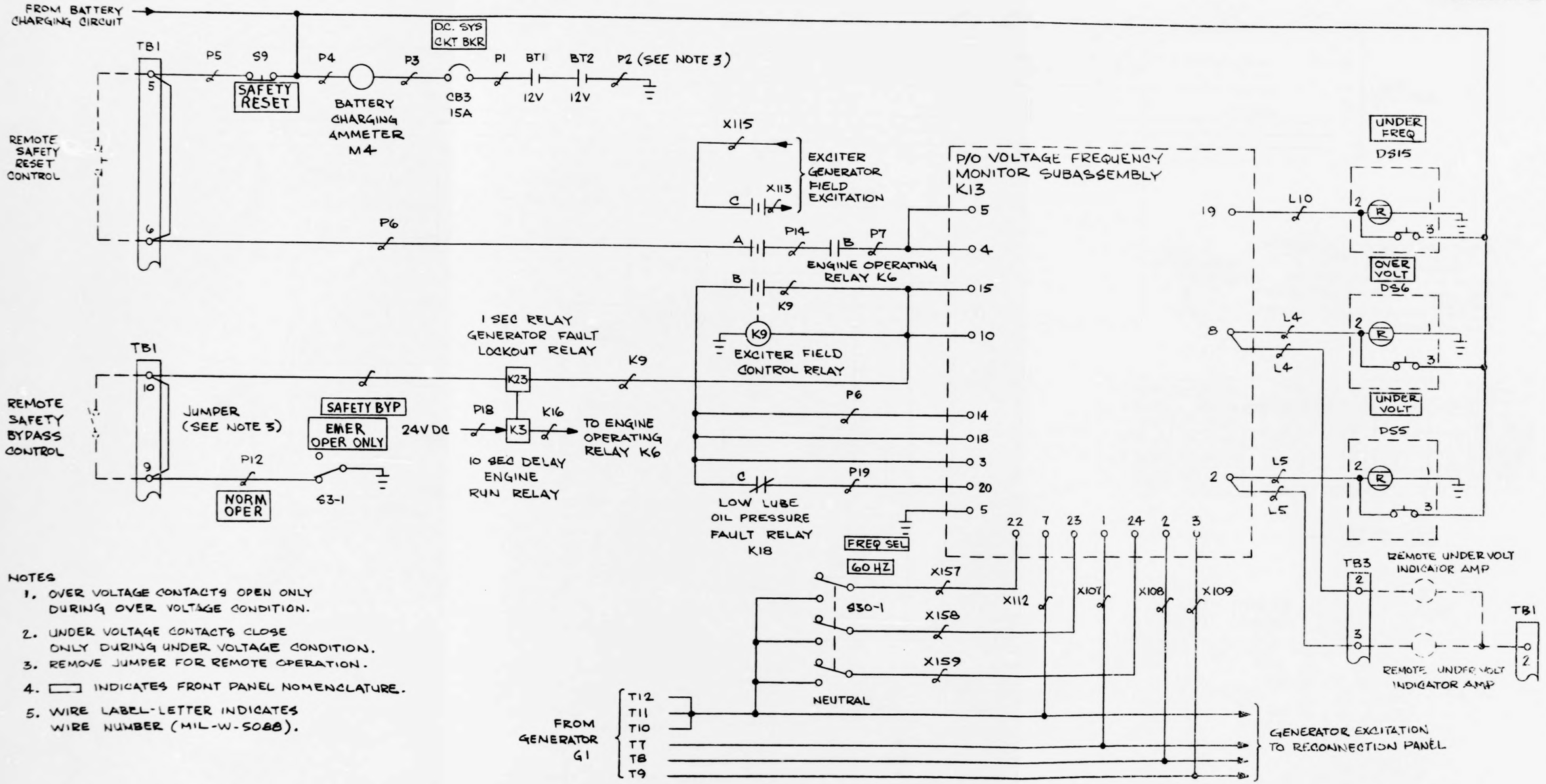


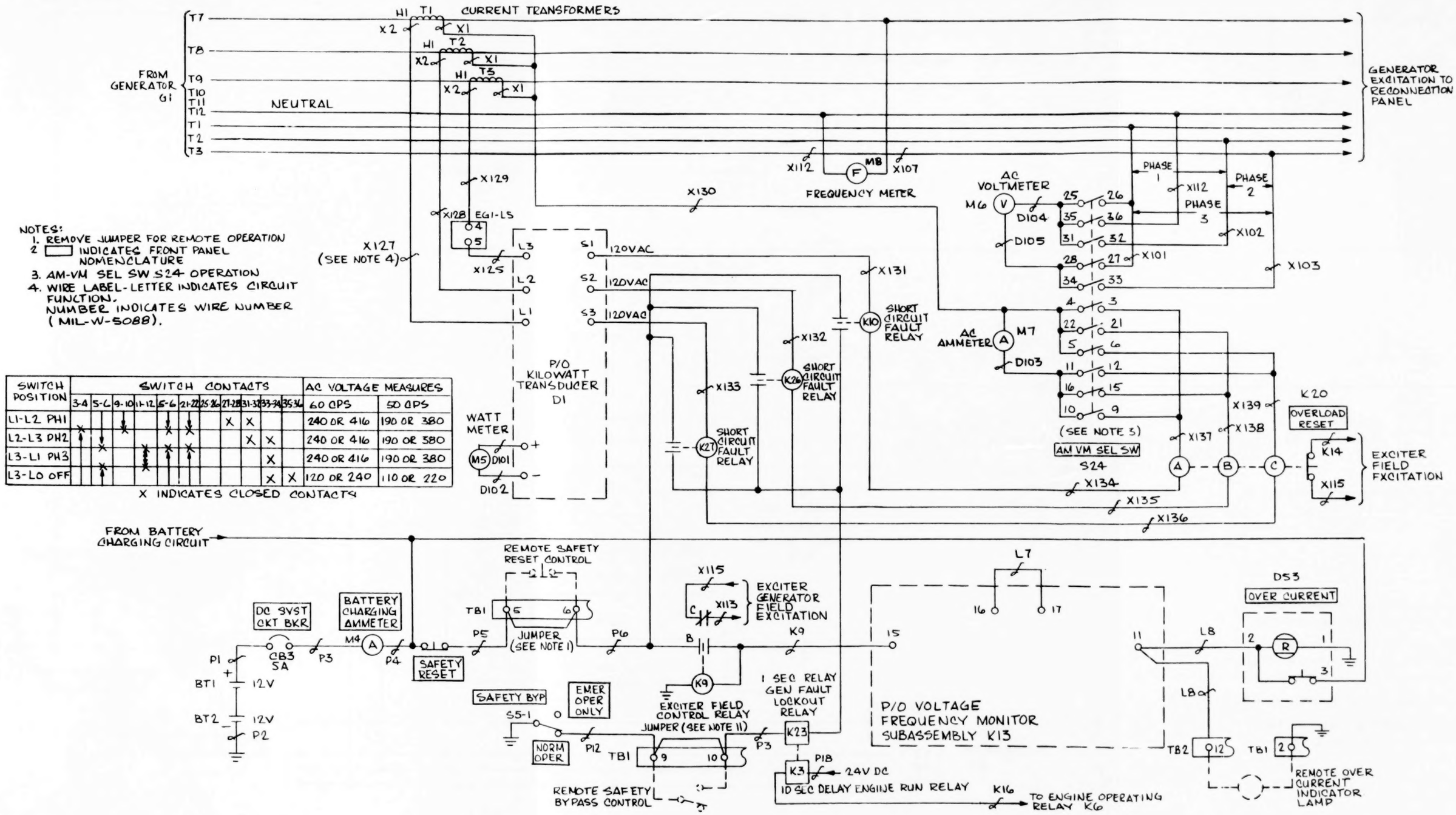
Figure 1-12. Engine Fault Circuits, Simplified Schematic Diagram



NOTES

1. OVER VOLTAGE CONTACTS OPEN ONLY DURING OVER VOLTAGE CONDITION.
2. UNDER VOLTAGE CONTACTS CLOSE ONLY DURING UNDER VOLTAGE CONDITION.
3. REMOVE JUMPER FOR REMOTE OPERATION.
4. ▭ INDICATES FRONT PANEL NOMENCLATURE.
5. WIRE LABEL-LETTER INDICATES WIRE NUMBER (MIL-W-5088).

Figure 1-13. Generator Fault Circuits (Over-Undervoltage), Simplified Schematic Diagram



SWITCH POSITION	SWITCH CONTACTS													AC VOLTAGE MEASURES	
	3-4	5-6	9-10	11-12	5-6	21-22	25-26	27-28	31-32	33-34	35-36			60 CPS	50 CPS
L1-L2 PH1								X	X					240 OR 416	190 OR 380
L2-L3 PH2									X	X				240 OR 416	190 OR 380
L3-L1 PH3										X				240 OR 416	190 OR 380
L3-L0 OFF										X	X			120 OR 240	110 OR 220

X INDICATES CLOSED CONTACTS

Figure 1-14. Generator Fault Circuits (Over Current and Short Circuit), Simplified Schematic Diagram

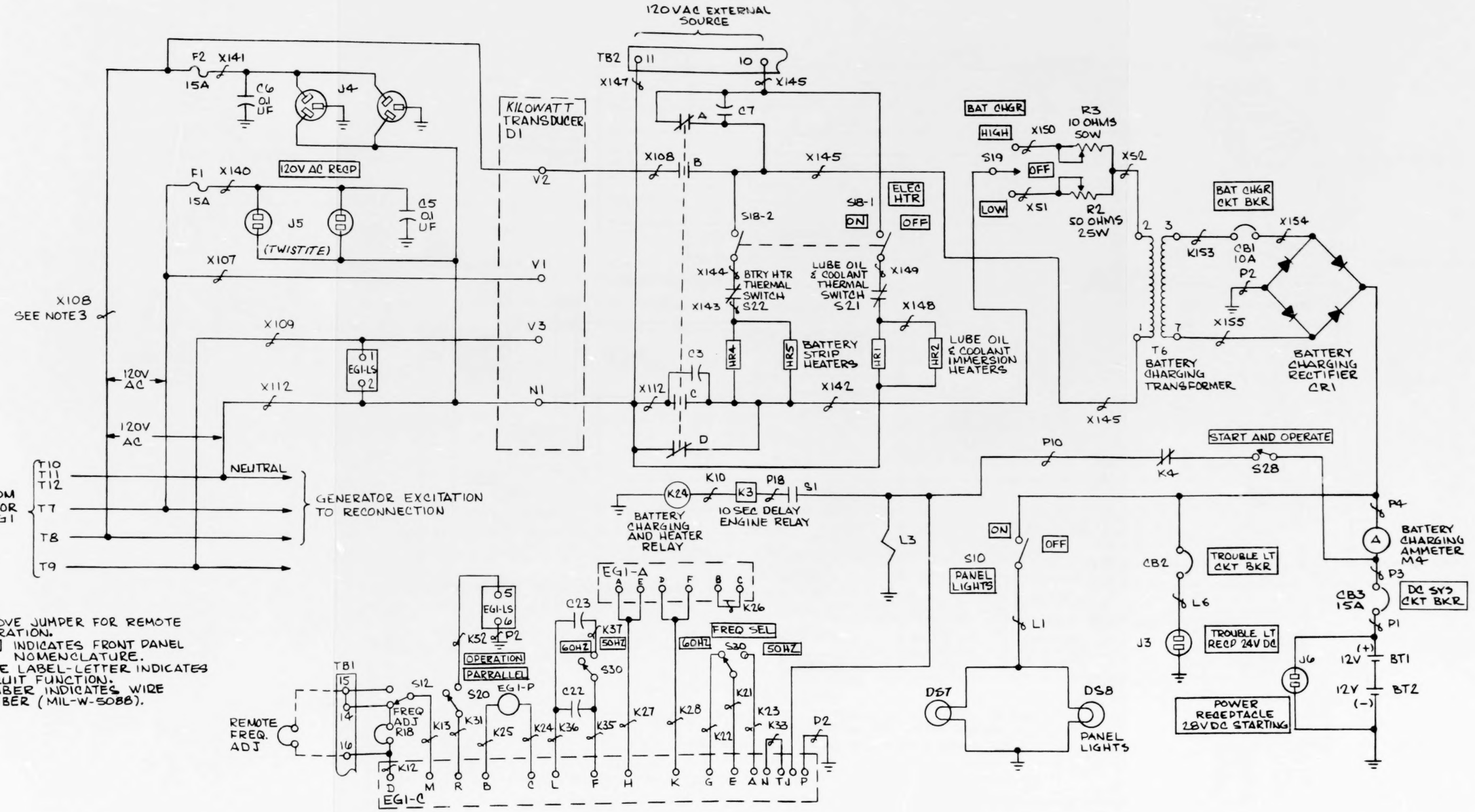
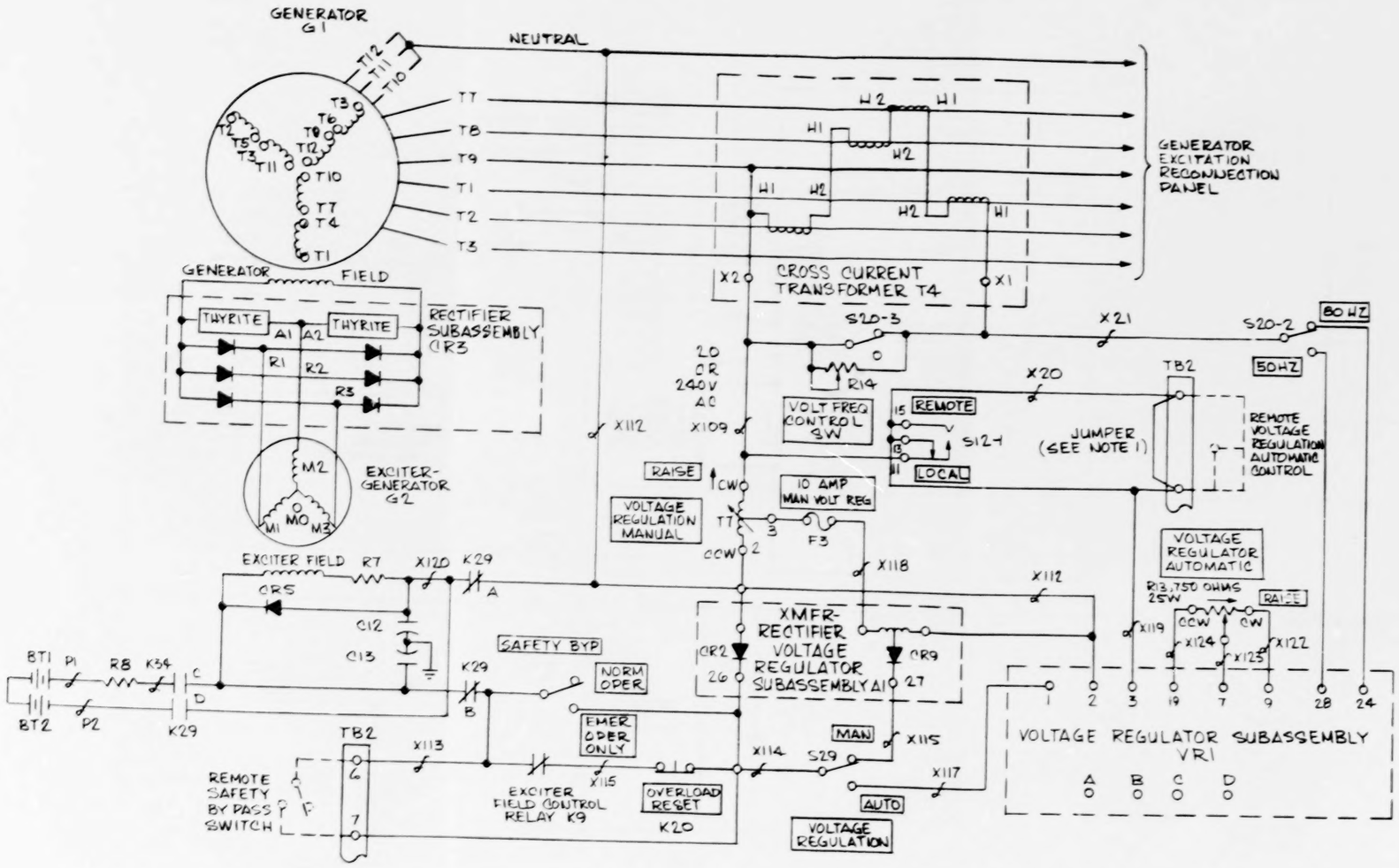


Figure 1-15. Battery Charging, Electric Heater, and Speed Control Circuits, Simplified Schematic Diagram



NOTES:
1. REMOVE JUMPED FOR REMOTE OPERATION.
2. ▭ INDICATES FRONT PANEL NOMENCLATURE.

Figure 1-16. Generator and Exciter - Generator Control Circuits, Simplified Schematic Diagram

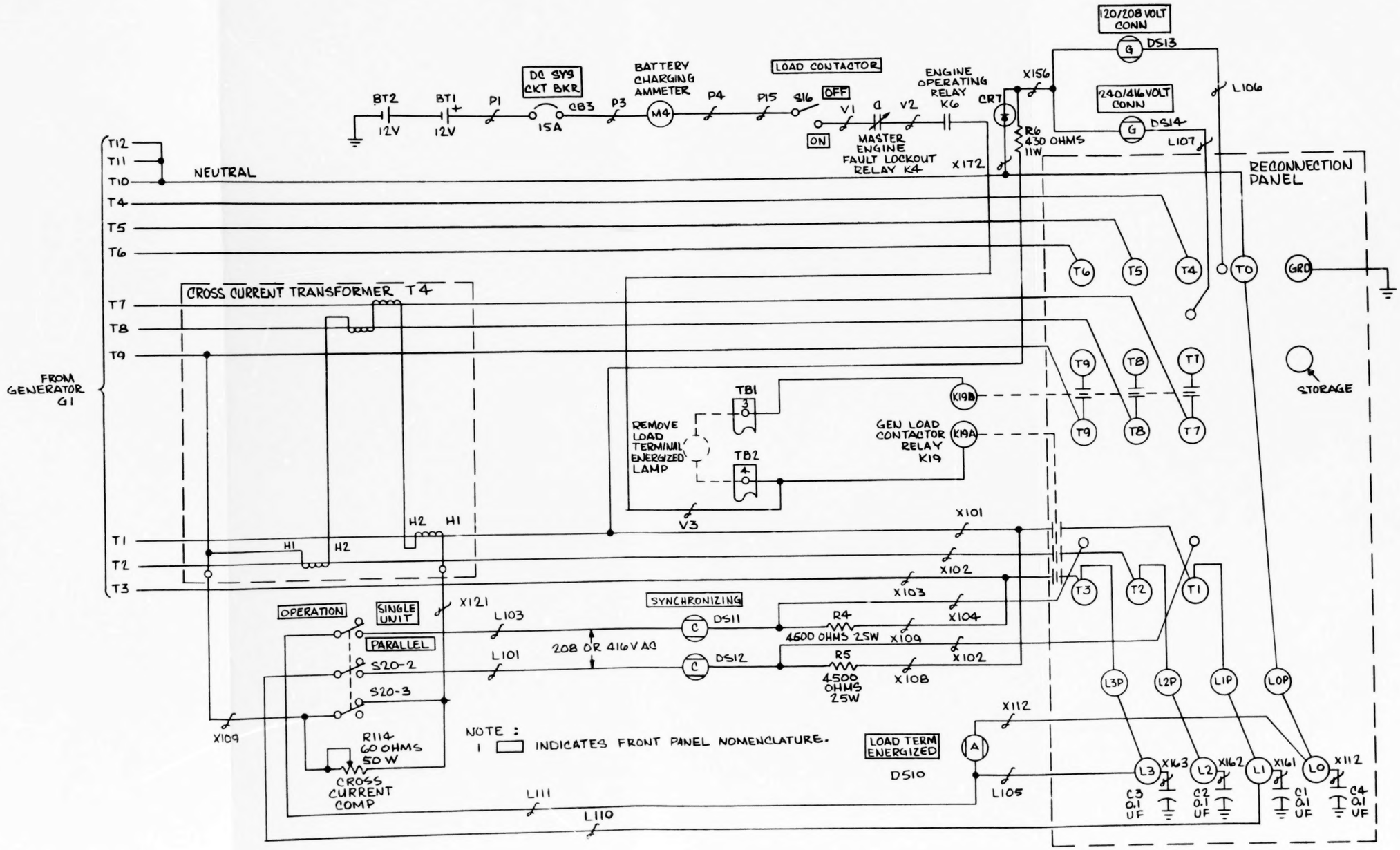


Figure 1-17. Reconnection Panel and Synchronizing Circuits, Simplified Schematic Diagram

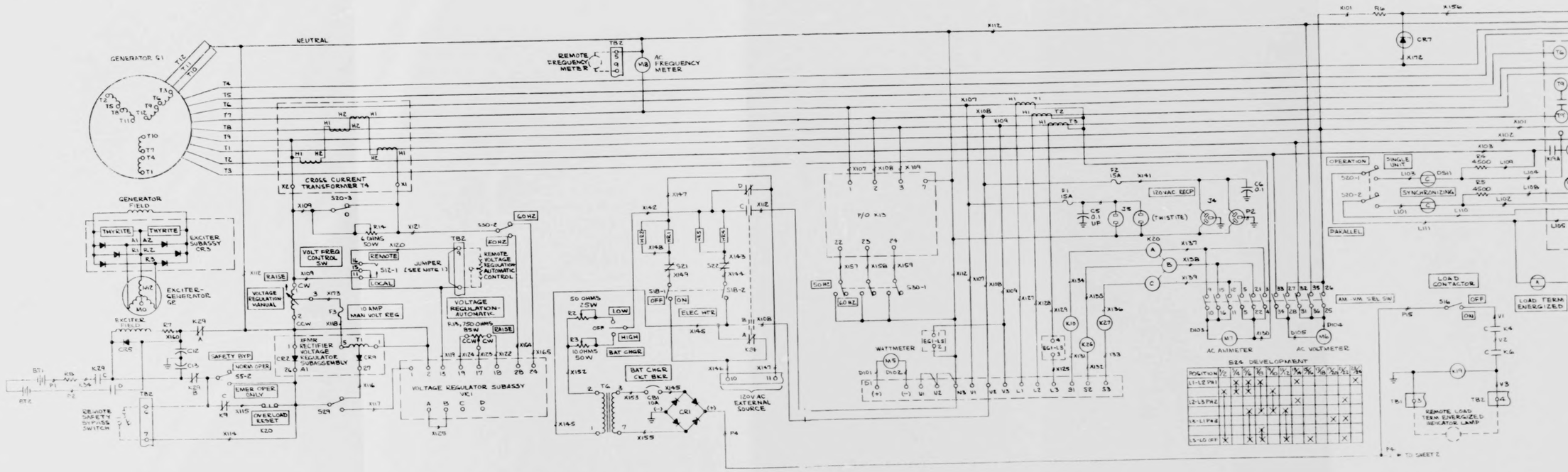


Figure 6-3. Engine-Generator Set Electrical and Control System Schematic Diagram (Sheet 1)

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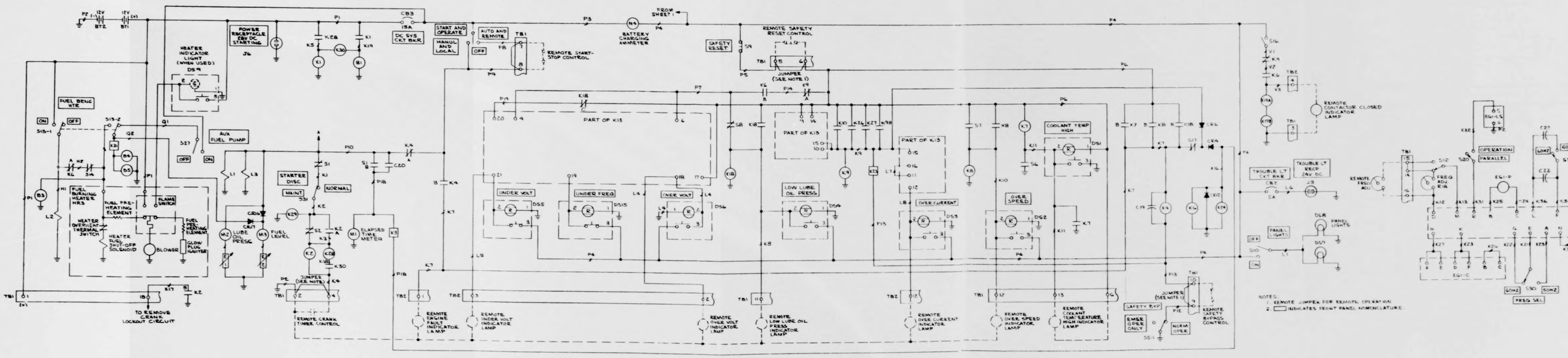

Figure 6-3. Engine-Generator Set Electrical and Control System Schematic Diagram (Sheet 2)

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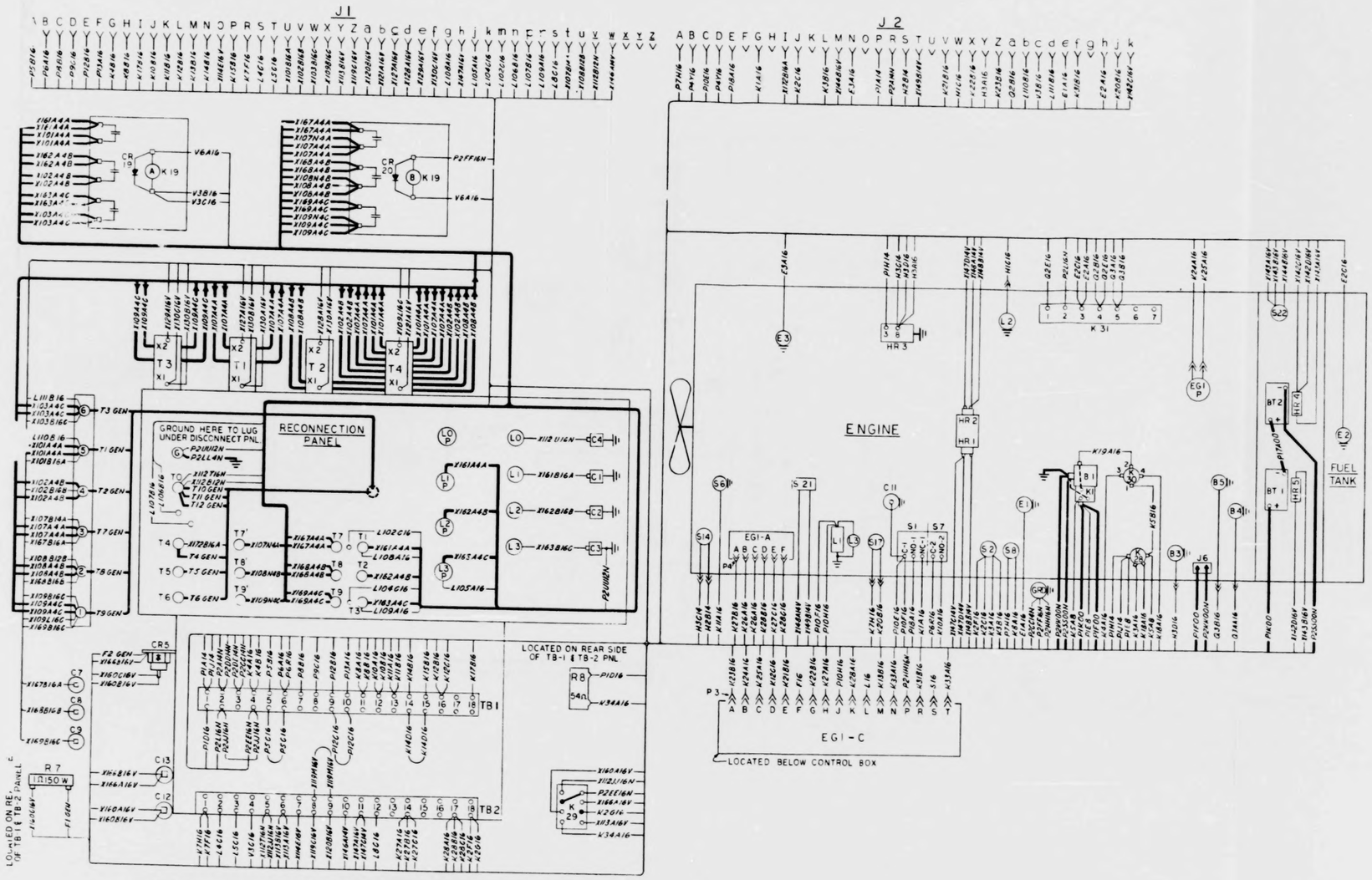

Figure 6-4. Engine-Generator Set Electrical and Control System Wiring Diagram

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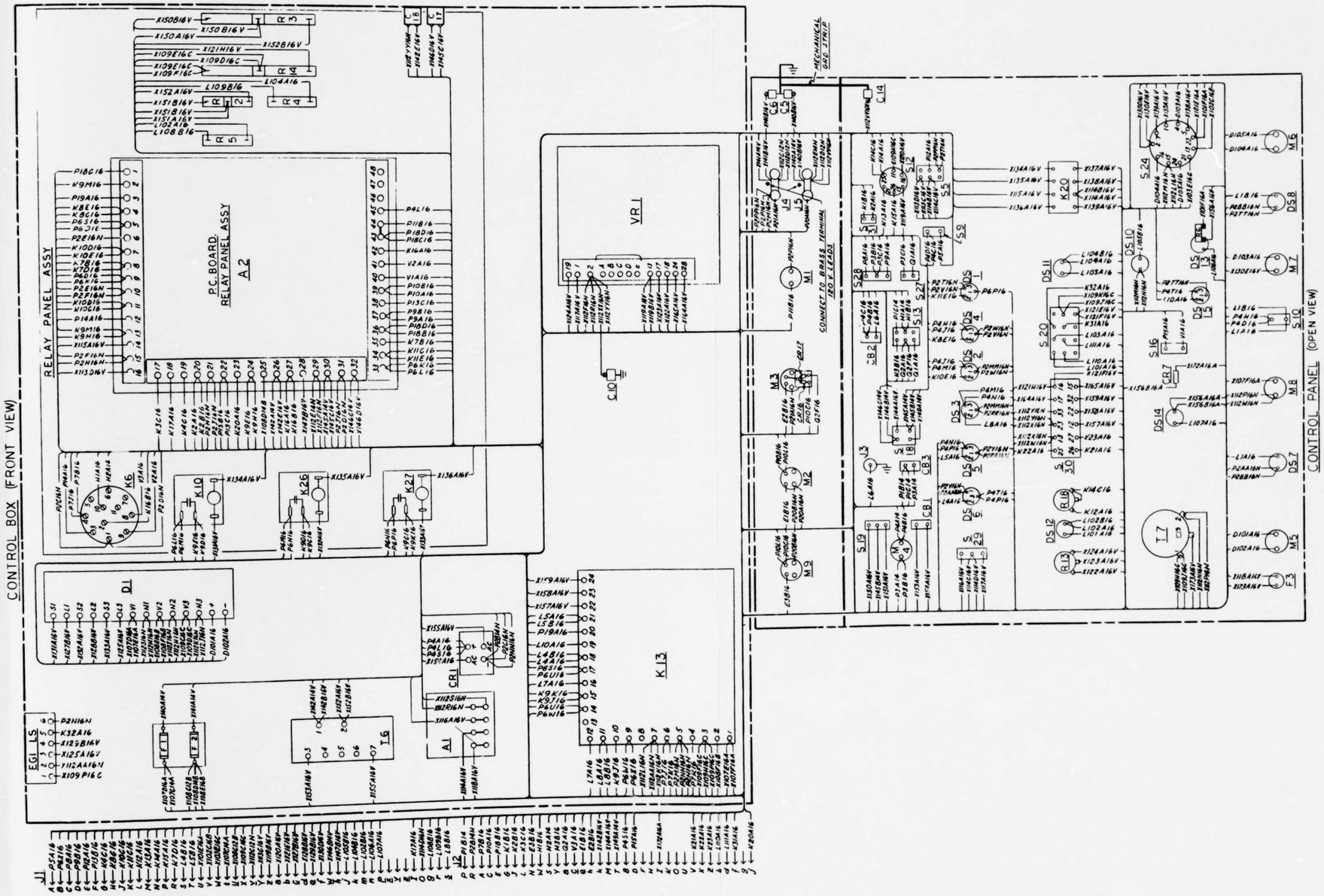
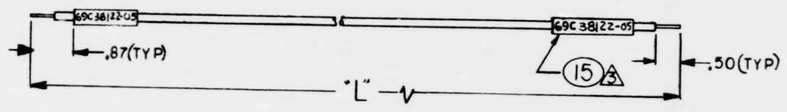


Figure 6-5. Engine-Generator Set Control Box, Wiring Diagram

Reproduced from poor document.

DASH NO. (DWG. 69C38122)	NO. REQ'D	WIRE NO.	WIRE FIND NO. (SEE LIST OF MATERIALS)	LENGTH (IN.)	COLOR	FROM	LUG FIND NO. (SEE LIST OF MATERIALS)	TO	LUG FIND NO. (SEE LIST OF MATERIALS)
01	2	X101A4A	2	74	WHITE	TB3-5	8	K19A	-
03	2	X102A4B	2	65	WHITE	TB3-4	8	K19A	-
05	2	X103A4C	2	56-1/2	WHITE	TB3-6	8	K19A	-
07	2	X107A4A	2	66	WHITE	TB3-3	8	K19B	-
09	1	X107N4A	2	45	WHITE	T7	9	K19B	-
11	2	X108A4B	2	63	WHITE	TB3-2	8	K19B	-
13	1	X108N4B	2	44-1/2	WHITE	T8	9	K19B	-
15	2	X109A4C	2	61-1/2	WHITE	TB3-1	8	K19B	-
17	1	X109N4C	2	45	WHITE	T9	9	K19B	-
19	1	X161A4A	2	52	WHITE	LB-L1-P	10	K19A	-
21	1	X161A4A	2	54	WHITE	LB-T1	9	K19A	-
23	1	X162A4B	2	51	WHITE	LB-L2-P	10	K19A	-
25	1	X162A4B	2	53	WHITE	LB-T2	9	K19A	-
27	1	X163A4C	2	52-1/2	WHITE	LB-L3-P	10	K19A	-
29	1	X163A4C	2	54-1/2	WHITE	LB-T3	9	K19A	-
31	2	X167A4A	2	43	WHITE	T7	9	K19B	-
33	2	X168A4B	2	43	WHITE	T8	9	K19B	-
35	2	X169A4C	2	43-1/2	WHITE	T9	9	K19B	-
37	1	K5A8	3	10	WHITE	K1	7	K28	6
39	1	P1F8	3	11	WHITE	K1	7	K28	11
41	1	P1F00	1	24	WHITE	K1	12	J6	11
43	1	P2KK00N	1	26-1/2	WHITE	B1	12	J6	11
45	1	P2LI4N	2	36	WHITE	G(Recon. Pnl)	10	GRD	8
47	1	P2UU12N	4	12	WHITE	GRD(Cap. Brkt)		G (Recon PNL)	5

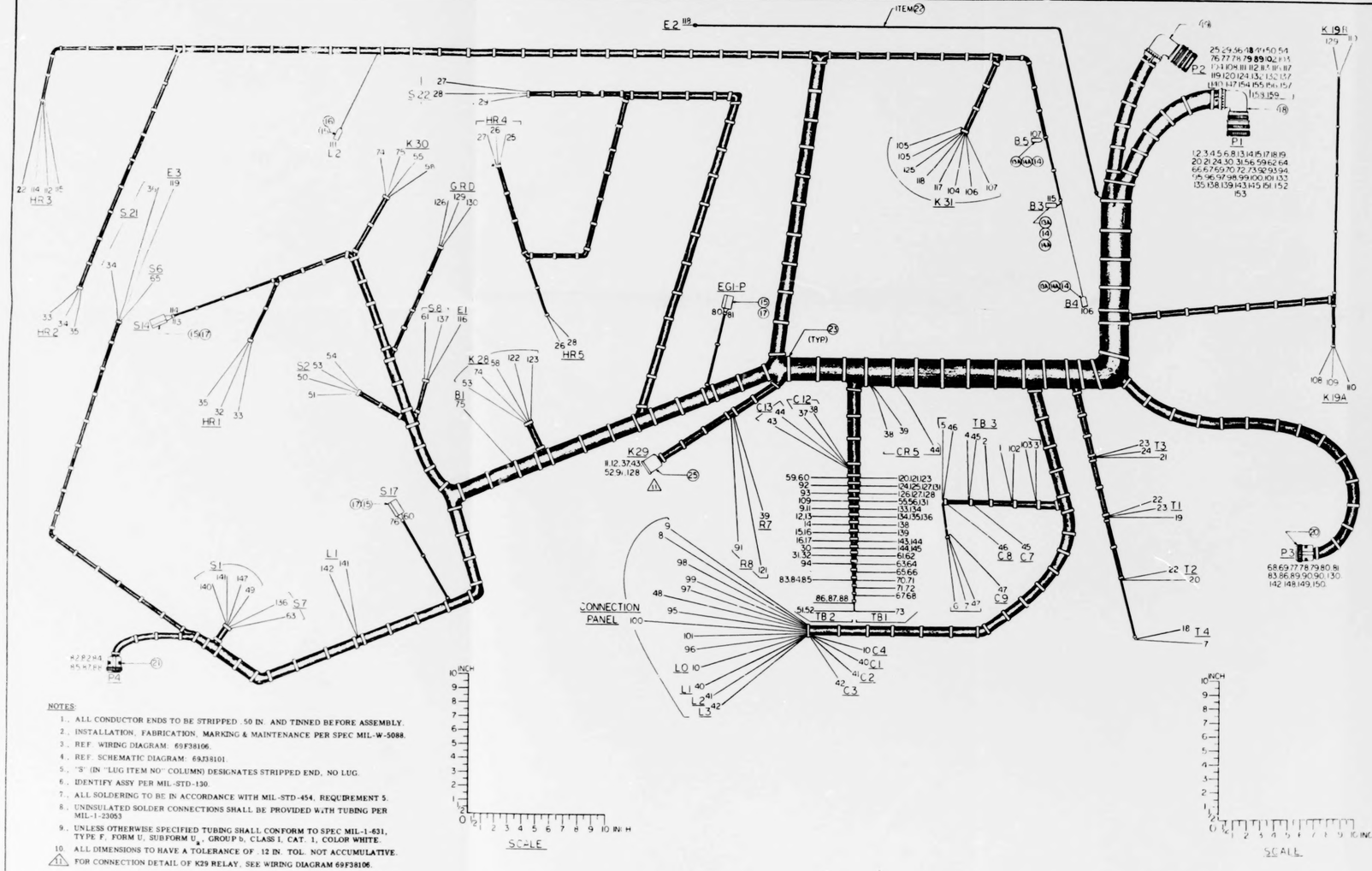


NOTES

1. ALL CONDUCTOR ENDS TO BE TINNED BEFORE ASSY.
2. WIRING FABRICATION MARKING INSTALLATION & MAINTENANCE OF PER SPEC MIL-W-5088.
3. MARK WITH ASSY NO & APPLICABLE DASH PER SPEC MIL-STD-130.
4. SEE DWG 69F38106 FOR WIRING DIAGRAM.
5. SOLDER PER MIL-S-6872, USING SN60 SOLDER., FORM W., TYPE R., CORE COND P2., PER SPEC QQ-S-571. NON-CORROSIVE FLUXES SHALL BE USED.
6. PLASTIC TUBING TYPE A; FORM U; SUBFORM Ua; GRADE a; CL I; CATEGORY 1., COLOR WHT.
7. A DASH IN THE LUG FIND NO. COLUMN DESIGNATES STRIPPED END NO LUG

QTY REQD.	LIST OF MATERIALS					
	SYM	NOMENCLATURE	CODE IDENT	IDENTIFYING NO.	SPECIFICATION	FIND NO
A/R	6	INSULATION TUBING			MIL-I-631	15
A/R	5	SOLDER			MIL-S-6872	14
30		STRAP, CABLE, ADJ.		MS17821-3-9		13
2		LUG, CRIMP STYLE, INS.		MS25036-137		12
2		LUG, CRIMP STYLE, INS.		MS25036-136		11
4		LUG, CRIMP STYLE, INS.	59730	RF 9751		10
12		LUG, CRIMP STYLE, INS.	59730	RF 9741		9
13		LUG, CRIMP STYLE, INS.		MS25036-123		8
2		LUG, CRIMP STYLE, INS.	59730	RD 9751		7
2		LUG, CRIMP STYLE, INS.		MS25036-117		6
1		LUG, CRIMP STYLE, INS.		MS25036-158		5
1/2		WIRE, 600V, NO 12 AWG		M81044-2-12-9	MIL-W-81044/2	4
2 FT		WIRE, 600V, NO 8 AWG		M81044/2-8-9	↕	3
127 FT		WIRE, 600V, NO 4 AWG		M81044/2-4-9	MIL-W-81044/2	2
5 FT		WIRE, 600V, NO 2/0 AWG			MIL-W-22759	1

Figure 1-1A. Miscellaneous Cables



NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED .50 IN. AND TINNED BEFORE ASSEMBLY.
2. INSTALLATION, FABRICATION, MARKING & MAINTENANCE PER SPEC MIL-W-5088.
3. REF. WIRING DIAGRAM: 69F38106.
4. REF. SCHEMATIC DIAGRAM: 69J38101.
5. "S" (IN "LUG ITEM NO" COLUMN) DESIGNATES STRIPPED END, NO LUG.
6. IDENTIFY ASSY PER MIL-STD-130.
7. ALL SOLDERING TO BE IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 5.
8. UNINSULATED SOLDER CONNECTIONS SHALL BE PROVIDED WITH TUBING PER MIL-I-23053.
9. UNLESS OTHERWISE SPECIFIED TUBING SHALL CONFORM TO SPEC MIL-I-631, TYPE F, FORM U, SUBFORM U_a, GROUP b, CLASS 1, CAT. 1, COLOR WHITE.
10. ALL DIMENSIONS TO HAVE A TOLERANCE OF .12 IN. TOL. NOT ACCUMULATIVE.

(11) FOR CONNECTION DETAIL OF K29 RELAY, SEE WIRING DIAGRAM 69F38106.

STA NO.	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. SEE SHEET 2	FROM	LUG ITEM NO. SEE SHEET 2	TO	LUG ITEM NO. SEE SHEET 2
80	W24A16	16	66 1/2	3	P3-B	S	EGI-P	15(17)
79	W21B16	16	55 3/4	3	P2-Z	S	P3-A	3
78	W22B16	16	50 3/4	3	P2-X	S	P3-G	3
77	W21B16	16	55 3/4	3	P2-Y	S	P3-E	3
76	W20B16	16	91 1/2	3	S17	15	P2-J	3
75	W12A16	16	76 1/2	3	P1	10	X30-E	5
74	W18A16	16	42	3	K29	7	X30-A	5
73	W17B16	16	65 1/4	3	TB1-10	6	P1-T	3
72	W15B16	16	62 1/4	3	TB1-9	6	P1-R	3
71	W14D16	16	3	3	TB1-14	6	TB1-15	6
70	W14B16	16	41 1/2	3	TB1-4	6	P1-N	3
69	W13B16	16	55 3/4	3	P3-M	5	P1-M	3
68	W12C16	16	65 1/2	3	TB1-16	6	P1-D	3
67	W12B16	16	62 1/2	3	TB1-16	6	P1-L	3
66	W11B16	16	60 1/2	3	TB1-8	6	P1-K	3
65	W11A16	16	109	3	TB1-13	6	S6	7
64	W10B16	16	61 1/2	3	TB1-12	6	P1-J	3
63	W10A16	16	79 1/2	3	TB1-12	6	S7-1/12	6
62	W8B16	16	60 3/4	3	TB1-11	A	P1-H	3
61	W8A16	16	59 3/4	3	TB1-11	6	S3	6
60	W7A16	16	56 1/2	3	TB2-1	6	S17	15(17)
59	W7B16	16	54	3	TB2-1	6	P1-P	3
58	W5B16	16	47 1/2	3	K30-1	5	K28	9
57	—	—	—	—	—	—	—	—
56	W4B16	16	56 1/4	3	TB1-6	6	P1-G	3
55	W4A16	16	69 1/4	3	TB1-4	6	X30-3	5
54	W3B16	16	88	3	S2	6	P2-L	3
53	W3A16	16	29	3	S2	6	K28	7
52	W2B16	16	36 1/4	3	TB2-18	6	K29	5
51	W2T16	16	62 1/4	3	TB2-18	6	S2	6
50	W2C16	16	89	3	S2	6	P2-J	3
49	W1A16	16	109	3	S1-NC1	6	P2-G	3
48	X172B16A	16	71 1/2	3	T4	10	P2-I	3
47	X169B16C	16	12	3	C9	6	TB3-1	8
46	X168B16B	16	12	3	C8	6	TB3-2	8
45	X167B16A	16	12	3	C7	6	TB3-3	8
44	X166B16V	16	15 1/4	3	C13	6	CR5	8
43	X164A16V	16	25	3	K29	5	C13	6
42	X163B16C	16	12	3	L3	10	C3	6
41	X162B16B	16	12	3	L2	10	C2	6
40	X161B16A	16	12	3	L1	10	C1	6
39	X160D16V	16	20 1/4	3	CR5	4	R7	5
38	X160B16V	16	14 1/2	3	C12	6	CR5	4
37	X160A16V	16	24	3	K29	5	C12	6
36	X149B14V	14	143 1/4	2	S21	5	P2-T	3
35	X148B16V	14	145	2	HR1	7	HR2	7
34	X148A14V	14	168	2	S21	5	HR2	7
33	X147D14V	14	145 1/2	2	HR1	7	HR2	7
32	X147C14V	14	79 3/4	2	TB2-11	6	HR1	7
31	X147A16V	16	60 1/4	3	TB2-11	6	P1-S	3
30	X146A14V	14	52 1/2	2	TB2-10	6	P1-U	3
29	X144B16V	16	101	3	S22	6	P2-M	3
28	X143B16V	16	34 1/4	3	HR5	7	S22	6
27	X143A16V	16	17	3	T2	6	HR4	7
26	X142D16V	16	15 1/2	3	HR5	7	HR4	7
25	X142C16V	16	116 1/4	3	HR4	7	P2-S	3
24	X132C16V	16	38 1/4	3	T3-X1	7	P1-E	3
23	X130B15V	16	11 1/2	3	T3-X1	7	T1-X1	7
22	X130A16V	16	11 1/2	3	T2-X1	7	T1-X1	7
21	X129A16V	16	38 1/2	3	T3-X2	7	P1-R	3
20	X128A16V	16	49	3	T2-X2	7	P1-V	3
19	X127A16V	16	43	3	T1-X2	7	P1-S	3
18	X121A16V	16	52	3	T4-X1	7	P1-B	3
17	X120B16V	16	58 1/4	3	TB2-9	6	P1-3	3
16	X119M16V	16	3	3	TB2-5	6	TB2-9	6
15	X119C16V	16	59	3	TB2-8	6	P1-2	3
14	X114E16V	16	59 3/4	3	TB2-7	6	P1-D	3
13	X113B16V	16	58	3	TB2-6	6	P1-V	3
12	X113A16V	16	57 1/4	3	TB2-6	6	K29	5
11	X112J16N	16	27	3	TB2-5	6	K29	3
10	X112U16N	16	12	3	L0	10	C4	6
9	X112T16N	16	69	3	TB2-5	6	TO	10
8	X112B12N	12	7 3/4	1	TO	12	P1-1	3
7	X109L16C	16	50	3	TB3-1	8	T4-12	7
6	X103B16C	16	55 1/2	3	TB3-1	8	P1-A	3
5	X103B12B	12	52 1/4	1	T4-12	11	T1-H	3
4	X107B14A	14	50 1/4	2	TB3-3	8	P1-K	3
3	X103B16C	16	46 1/4	3	TB3-6	8	P1-W	3
2	X102B16B	16	90	3	TB3-4	8	T1-V	3
1	X101B16A	16	48	3	TB3-5	8	P1-U	3

STA NO.	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. SEE SHEET 2	FROM	LUG ITEM NO. SEE SHEET 2	TO	LUG ITEM NO. SEE SHEET 2
159	SMALL G16	16	12	3	P2-9	S	—	—
158	U12	12	12	1	P2-11	S	—	—
157	D12	12	12	1	P2-D	S	—	—
156	K16	16	12	3	P2-K	S	—	—
155	H16	16	12	3	P2-H	S	—	—
154	F16	16	12	3	P2-F	S	—	—
153	SMALL Z12	12	12	1	P1-3	S	—	—
152	SMALL Y12	12	12	1	P1-2	S	—	—
151	SMALL X12	12	12	1	P1-1	S	—	—
150	S16	16	12	3	P3-S	S	—	—
149	L16	16	12	3	P3-L	S	—	—
148	F16	16	12	3	P3-F	S	—	—
147	T1A16	16	109 1/2	3	S1-T01	4	P2-E	5
146	—	—	—	—	—	—	—	—
145	P13A16	16	61 1/2	3	TB1-10	6	P1-F	5
144	P12C16	16	3	3	TB-9	6	TB1-10	6
143	P12E16	16	60 3/4	3	TB1-9	6	P1-E	3
142	P10H16	16	38	3	L1	7	P3-J	3
141	P10F16	16	23	3	L1	7	S1-C1	6
140	P10E16	16	109	3	S1-C1	6	P2-C	5
139	P9C16	16	60 1/2	3	TB1-9	6	P1-D	3
138	P8B16	16	59 3/4	3	TB1-7	6	P1-C	3
137	P7N16	16	88	3	TB1-7	6	P1-A	6
136	P6A16	16	77	3	TB1-6	6	S7-C3	6
135	P6A16	16	59 1/4	3	TB1-6	6	P1-B	3
134	P5C16	16	3	3	TB1-5	6	TB1-6	6
133	P5B16	16	58 1/4	3	TB1-5	6	P1-A	3
132	P4J16	16	6	3	P3-R	5	P2-D	5
131	P2J16N	16	3 1/2	3	TB1-2	6	TB1-4	6
130	P2H16N	16	101 1/2	3	P3-P	5	GND	10
129	P2F16N	16	110 1/4	3	GND	13	K19B	7
128	P2E16N	16	26 1/4	3	TB1-3	6	K29	3
127	P2D16N	14	3	2	TB1-2	6	TB1-3	6
126	P2C16N	14	65 1/4	2	TB1-3	6	GND	10
125	P2J16N	16	60 3/4	3	TB1-2	6	K31-2	5
124	P2A14N	14	53 1/2	2	TB1-2	6	P2-R	3
123	P1J14	14	19 1/2	2	TB1-1	6	K28	9
122	P1H19	14	107 1/2	2	K28	9	W13-3	6
121	P1D16	16	29 1/2	3	TB1-1	6	K8	5
120	P1A14	14	53 1/2	2	TB1-1	6	P2-P	5
119	E3A16	16	144	3	E3	7	P2-N	5
118	E2C16	16	120	3	K31-3	5	E2	7
117	E2A16	16	94	3	K31-3	5	P2-A	5
116	E1A16	16	87 1/2	3	E1	7	P2-E	5
115	H3J16	16	92	3	W13-3	6	P2-J	14
114	H3C14	14	144	2	S14	15	W13-3	6
113	H2B14	14	108	2	S14	15(17)	P2-S	5
112	H3A16	16	144	3	P2-Y	S	HR3-B	6
111	H1C16	16	117 3/4	3	L2	15(16)	P2-N	5
110	V8A16	16	24	3	K19A	7	K19B	7
109	V3C16	16	55 1/4	3	TB2-4	6	K19A	7
108	V3B16	16	44	3	P2-E	S	K19A	7
107	Q3B16	16	15 3/4	3	K31-5	S	B5	14
106	Q3A16	16	28 1/2	3	K31-5	S	B4	14
105	Q2E16	16	4	3	K31-1	S	K31-4	S
104	Q2B16	16	93 1/4	3	K31-4	S	P2-B	S
103	L11B16	16	44	3	TB3-6	8	P2-H	S
102	L11D16	16	45 1/2	3	TB3-5	8	P2-B	S
101	L10A16	16	72 1/2	3	T3-1	10	P1-L	S
100	L10A16	16	74	3	T3-1	10	P1-3	S
99	L10T16	16	70 1/4	3	(K10A PIN)	8	P1-R	S
98	L10E16	16	12 1/2	3	(K10A PIN)	8	P1-N	S
97	L10S16	16	12 3/4	3	L3-P	10	P1-1	S
96	L10C16	16	70 1/4	3	(K10A PIN)	8	P1-K	S
95	L10Z16	16	72	3	(K10A PIN)	8	P1-M	S
94	L8C16	16	59 1/2	3	TB2-12	6	P1-3	S
93	L5C16	16	56	3	TB1-3	6	P1-T	S
92	L4C16	16	55 1/4	3	TB2-2	6	P1-S	S
91	K34A16	16	14 1/2	3	P3-T	S	K29	5
90	K33A16	16	6	3	P3-N	S	P1-T	S
89	K31-16	16	61	3	P2-E	S	P1-R	S
88	K28C16	16	65 1/2	3	TB2-17	6	P2-F	5
87	K27-B16	16	85 1/2	3	TB2-17	6	P1-D	5
86	K24A16	16	87 1/2	3	T3-2	C	P3-R	5
85	K27C16	16	83 1/4	3	TB2-14	6	P4-E	5
84	K27B16	16	83 1/4	3	TB2-14	C	P1-A	5
83	V27A16	16	65	3	P3-H	S	TB2-14	6
82	L26A16	16	61	3	P4-B	S	P4-C	S
81	K45A16	16	63 1/4	3	P3-C	S	EGI-P	15

Figure 2-1A. Unit Wiring Harness and Cutting List (Sheet 1 of 2)

Legend To Figure 2-2

1. Housing Roof
2. Access Door
3. Bottom Door
4. Latch
5. Top Rear Side Door
6. Shutter Assembly
7. Corner Front LH Panel
8. Corner Rear, LH Panel
9. Access Cover
10. Grommet
11. Side Front LH Panel
12. Side Bottom Rear LH Panel
13. Side Top Panel
14. Access Cover
15. Center LH Panel
16. Door Holder
17. Door and Panel Assembly LH
18. Door and Panel Assembly, RH
19. Latch
20. Rear Bottom Panel
21. Grill Assembly
22. Housing Front Door
23. Latch
24. Front Center Panel
25. Housing Front Bottom Panel

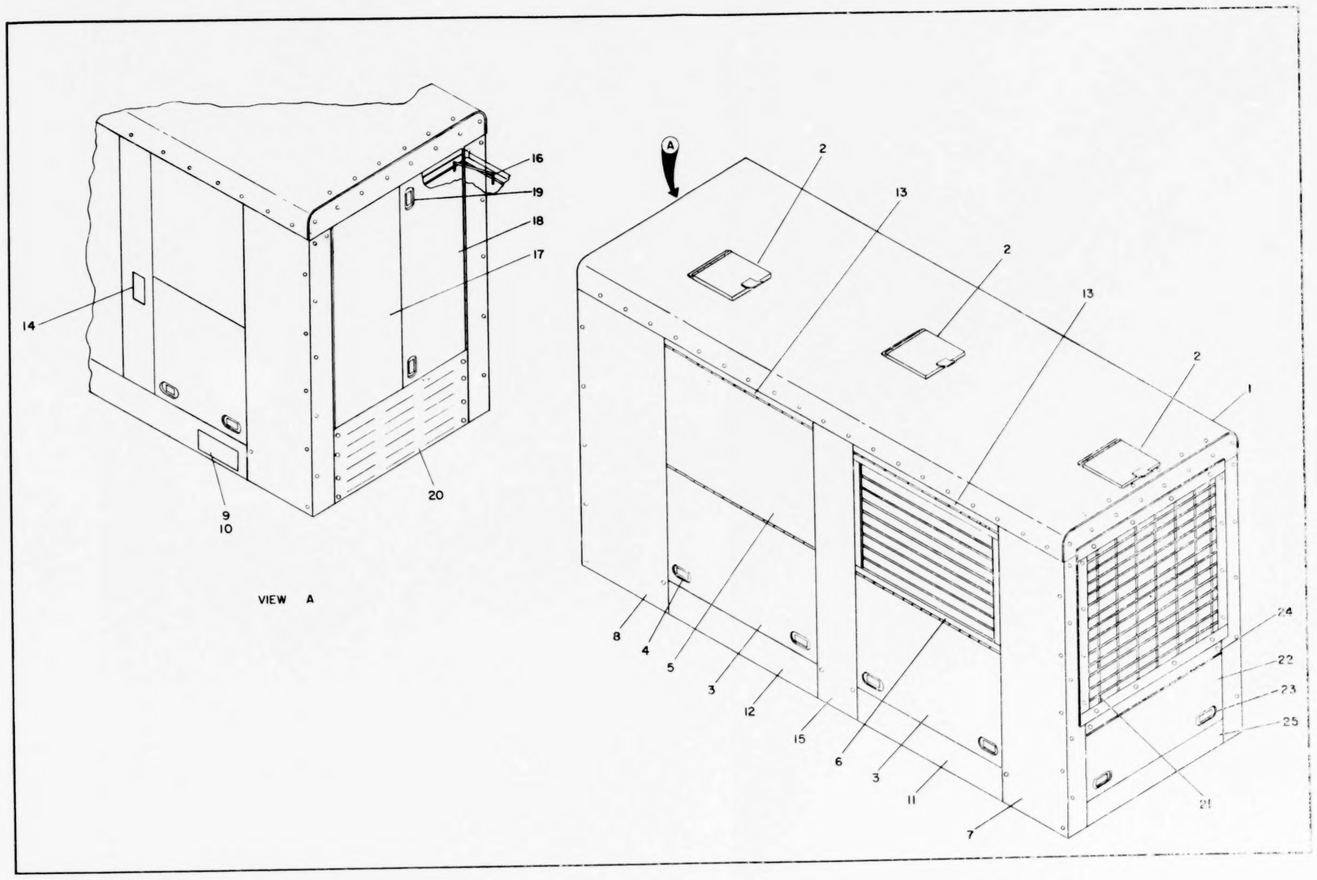
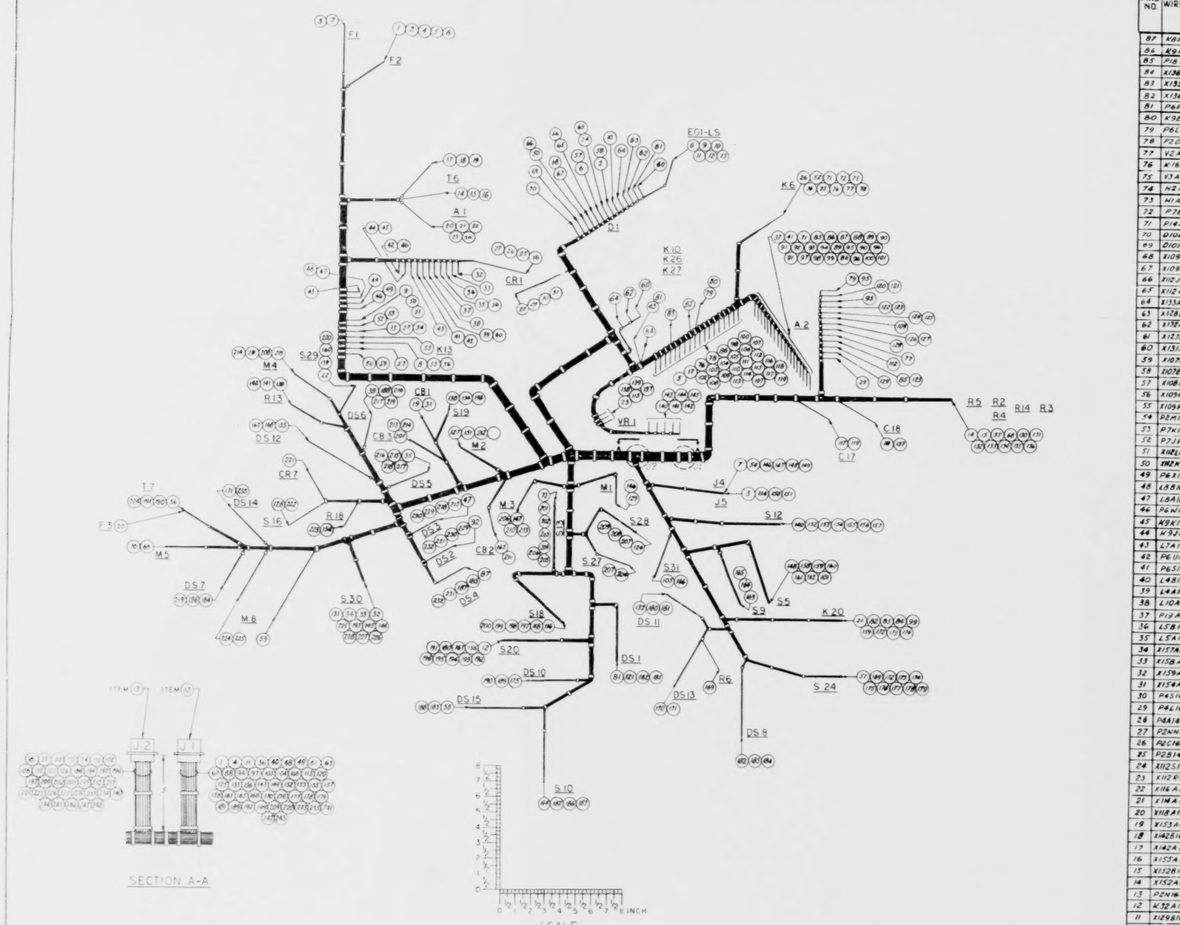


Figure 2-2. Housing Assembly



FIND NO	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. (SEE LIST OF MATL)	FROM	LUG ITEM NO. (SEE LIST OF MATL)	TO	LUG ITEM NO. (SEE LIST OF MATL)
87	X6R16	16	45¾	1	A2.4	4	DS4.2	–
86	X6M16	1	7	1	A2.2	4	A2.13	4
85	P16C16		51¾	1	A2.1	4	A2.23	4
84	X136A16Y		47½	1	K27	10	K20	6
83	X135A16Y		46	1	K26	10	K20	6
82	X136A16Y		46	1	K10	10	K20	6
81	P16F16		33	1	K27	10	DS1.1	–
80	K9E16		18	1	K10	10	A2.28	4
79	P6G16		46¾	1	K10	10	A2.33	4
78	P2D16N		18	1	K6.1	–	A2.31	4
77	V2A16		53	1	K6.9	–	A2.41	4
76	K16A16	1	14	1	K6.2	–	A2.27	4
75	V3A16	16	38	1	K6.8	–	J2.C	–
74	N2A16	16	38	2	K6.6	–	J2.S	–
73	N1A14	14	41½	2	K6.10	–	S13	4
72	P7E16	16	39	1	K6.4	–	J2.A	–
71	B16A16	1	14	1	K6.3	–	A2.12	4
70	U10Z416		45¾	1	D1.M1	4	M5	5
69	D10Z416		45¾	1	D1.M1	4	M12N	5
68	X10916C		53¾	1	D1.K3	4	R16	–
67	X10916C		50	1	D1.K3	4	J1.X	–
66	X12J16N		3	1	D1.N2	4	D1.N3	4
65	X12J16N		3	1	D1.N1	4	D1.N2	4
64	X13A16Y		42½	1	D1.S3	4	K27	10
63	X12B16Y		2¾	1	D1.L1	4	J1.C	–
62	X13716Y		19	1	D1.S2	4	K26	10
61	X12J16Y		23¾	1	D1.L1	4	J1.C	–
60	X13A16Y		20	1	D1.S1	4	K10	10
59	X10716A		39¾	1	K13.1	4	M3	–
58	J10716A		38¾	1	K13.1	4	J1.H1	4
57	X10B16B		37	1	K13.2	4	D1.V2	4
56	X10916C		45	1	K13.3	4	T7.1	4
55	X10916C		50	1	K13.3	4	R14	–
54	P2M16N		38½	1	K13.3	4	J4	17
53	P7J16		49¾	1	K13.6	4	K13.4	4
52	P7J16		48	1	K13.6	4	K6.4	–
51	X16J16N		49½	1	K13.7	4	S24.15	8
50	J16Z16N		39	1	K13.7	4	D1.N3	4
49	P6J16		35¾	1	K13.9	4	J1.B	–
48	L9J16		34¾	1	K13.11	4	J1.Z	–
47	L8A16		36¾	1	K13.12	4	DS3.2	–
46	P6W16		9	1	K13.14	4	K13.9	4
45	K9X16		49½	1	K13.15	4	K27	10
44	K9Z16		9	1	K13.15	4	K13.10	4
43	L7A16		9	1	K13.16	4	K13.12	4
42	P6U16		33¾	1	K13.17	4	K13.16	4
41	P6S16		57½	1	K13.17	4	A2.5	4
40	L4B16		43	1	K13.18	4	J1.S	–
39	L4A16		45¾	1	K13.18	4	D16.2	–
38	L10A16		54	1	K13.19	4	DS15.2	–
37	P12A16		58¾	1	K13.20	4	A2.3	4
36	L5A16		44½	1	K13.21	4	J1.T	–
35	L5A16		44½	1	K13.21	4	D55.2	4
34	X11716AY		49¾	1	K13.22	4	S30	4
33	X11816AY		50½	1	K13.23	4	S30	4
32	X11916AY		50¾	1	K13.24	4	S30	4
31	X11A16AY		51½	1	CR1.AC	7	CB1	5
30	P4S16	1	25¾	1	CR1.(4)	7	J2.B	–
29	P4L16	16	40	1	CR1.(4)	7	A2.45	4
28	P4A16	16	41	2	CR1.(4)	7	M4	5
27	P2N16N	16	17½	1	CR1.(–)	7	K13.5	4
26	P2C16N	16	64	1	CR1.(–)	7	K6.1	–
25	P2B16N	14	44	2	CR1.(–)	7	J2.R	–
24	X11216N	16	54	1	A1.1	4	D1.N1	4
23	X12R16N		56½	1	A1.1	4	VR1.2	5
22	X16A16Y		54¾	1	A1.27	4	S29	4
21	X14A16Y		55	1	A1.26	4	K20	6
20	X11A16Y		63¾	1	A1.5	4	F3	–
19	X15316Y		48	1	T6.3	4	CR1	5
18	X14Z16Y	16	45½	1	T6.1	4	J2.K	–
17	X14Z416Y	14	56½	2	T6.1	4	A2.26	4
16	X15316Y	16	29	1	T6.7	4	CR1.AC	7
15	X15216Y		75	1	T6.2	4	R3	–
14	X15216Y		74	1	T6.2	4	A2	–
13	P2N16N		33¾	1	F5F15.6	4	K13.2	4
12	K32A16		71	1	85H-L5.3	4	S20	4
11	X10916Y		65½	1	85H-L5.4	4	J1.E	–
10	X12516Y		71	1	85H-L5.5	4	DS.L3	4
9	X12AA16N	1	33	1	85H-L5.2	4	K13.7	4
8	X10916C	14	14½	1	85H-L5.1	4	K13.3	4
7	J1416Y	16	59¾	2	F2	5	J4	17
6	X10816B	14	4	1	F2	5	DI.V2	4
5	X10B016B	14	58½	2	F2	5	A2.25	4
4	X10BC12B	12	4	3	F2	II	J1.U	–
3	X140A16Y	14	59	2	F1	5	J3	17
2	X10721616	16	59½	1	F1	5	DI.V1	4
1	X107C14A	14	4	2	F1	5	J1.E	–

FIND NO	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. (SEE LIST OF MATL)	FROM	LUG ITEM NO. (SEE LIST OF MATL)	TO	LUG ITEM NO. (SEE LIST OF MATL)
178	X13916Y	14	15	1	K20	6	S24.7	8
177	X13A16Y	1	18	1	K20	6	S24.5	8
176	X13716Y		20	1	K20	6	S24.1	8
175	X13616Y		44¾	1	DS1.3	4	DS1.8	4
170	L10A16		26	1	DS13	4	J1.N	–
169	T10F16A		14	1	R6	–	S24.23	8
168	L10Z816		31	1	DS12	4	J1.M	–
167	L10A16		37¾	1	DS12	4	S20	4
166	K18J16		24½	1	S31	4	J2.G	–
165	P5A16		23¾	1	S9	4	J1.A	–
164	P4D16		38½	1	S9	4	S10	4
163	P4C16	16	24½	1	S9	4	C82	5
162	P2T20N	20	14	18	S5	4	DS1.3	–
161	P12A16	18	21¾	1	S5	4	J1.E	–
160	J1146Y		19½	1	S5	4	S33	4
159	X11A16Y		21¾	1	S5	4	K20	6
158	J1136Y		22¾	1	S5	4	J1.Y	–
157	X12016N		19½	1	S12.16	4	J1.B	–
156	J1096Y		33¾	1	S12.11	4	S20	4
155	K15A16		19	1	S12.26	4	J1.P	–
154	K14A16		32½	1	S12.25	4	K18	–
153	K14A16		18¾	1	S12.25	4	J1.N	–
152	K13A16		17½	1	S12.21	4	J1.M	–
151	P20A16N	1	24	1	J5	5	M2	5
150	V12916N	16	9½	1	J5	17	C14	6
149	V13012N	12	17¾	1	J4	3	J1.E	–
148	P2P16N	16	21½	1	J4	17	S5	4
147	P2A16N		18½	1	J4	5	M3	5
146	P2T16N		21	1	J4	17	M1	6
145	X16A16Y		43¾	1	VR1.28	5	S30	4
144	X16716Y		43¾	1	VR1.24	5	S30	4
143	X09916C		53	1	VR1.19	5	J1.D	–
142	T12A16Y		43	1	VR1.18	5	R13	–
141	X12316Y		42¾	1	VR1.17	5	R13	–
140	X10916Y		36½	1	VR1.13	5	S12.15	4
139	X11716Y		38¾	1	VR1.1	5	S39	4
138	X12A16Y		39¾	1	VR1.19	5	R13	–
137	X11Z916N		42¾	1	VR1.2	5	C18	–
136	L10A816		33	1	R5	–	J1.G	–
135	L10Z416		51¾	1	R5	–	DS12	4
134	X11A16Y		50½	1	R2	–	S19	4
133	L10B16		32½	1	R4	–	J1.R	–
132	L10A416		49½	1	R4	–	DS11	4
131	X12A16Y		57	1	R14	–	J.10	4
130	X13DA16Y		50½	1	R3	–	S19	4
129	P8B16		28½	1	AE.44	4	M1	4
128	V9A16		44¾	1	A2.40	4	S16	4
127	P10S16		45½	1	A2.35	4	M2	5
126	P10A16		25	1	A2.39	4	J2.C	–
125	P8S16		23¾	1	A2.37	4	J1.D	–
124	P8A16		34¾	1	A2.37	4	S28	4
123	P8D16		5	1	A2.36	4	A2.43	4
122	P8B16		25½	1	A2.36	4	J2.K	–
121	V8E16		40½	1	A2.34	4	D11.2	–
120	V8G16		24¾	1	A2.34	4	J1.K	–
119	J1146D16Y	16	57½	1	A2.32	4	C17	–
118	J1146E16Y	16	31¾	2	A2.32	4	S18	4
117	J1A5C16Y	16	36½	1	A2.30	4	C17	–
116	J1A516Y	14	30¾	2	A2.30	4	S18	4
115	J1127E16N	16	9	1	A2.29	4	VR1.2	5
114	J1126E16N	14	32¾	2	A2.29	4	J5	17
113	J1A716Y	16	29	1	A2.28	4	J1.H	–
112	K16A16	1	40	1	A2.27	4	A2.42	4
111	J1A2E16Y		41½	1	A2.26	4	C18	–
110	K20A16		32¾	1	A2.23	4	J2.L	–
109	P15C16		43½	1	A2.22	4	A2.38	4
108	P15B16		32	1	A2.22	4	J1.F	–
107	P2T16N		6¾	1	A2.21	4	A2.31	4
106	K28A16		29	1	A2.20	4	J2.J	–
105	K2A16		30	1	A2.20	4	S31	4
104	K9C16		33¾	1	A2.19	4	J1.B	–
103	K17A16		33¾	1	A2.18	4	J1.Z	–
102	K3C16		31¾	1	A2.17	4	J2.L	–
101	J1153D16Y		43	1	A2.16	4	S5	4
100	P2H16N		6¾	1	A2.15	4	A2.21	4
99	X13A16Y		31	1	A2.14	4	K20	6
98	K9A16		8¾	1	A2.13	4	A2.24	4
97	M10C16		38¼	1	A2.11	4	J1.J	–
96	P2T16N		5	1	A2.10	4	A2.11	4
95	P8G16		12	1	A2.9	4	A2.33	4
94	K7E16		37¼	1	A2.8	4	J1.W	–
93	K7E16		12	1	A2.8	4	A2.35	4
92	V10E16		46½	1	A2.7	4	DS2.2	–
91	M10D16		4	1	A2.7	4	A2.11	4
90	P2E16N		4	1	A2.6	4	A2.10	4
89	P6D16	1	4¾	1	A2.5	4	A2.9	4
88	X8E16	16	60½	1	A2.4	4	J1.W	–

FIND NO	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. (SEE LIST OF MATL)	FROM	LUG ITEM NO. (SEE LIST OF MATL)	TO	LUG ITEM NO. (SEE LIST OF MATL)
243	SMALL E20	12	12	3	J1.E	–	–	–
242	SMALL V12	12	12	3	J1.Y	–	–	–
241	SMALL F12	12	12	3	J1.F	–	–	–
240	SMALL G16	16	12	1	J2.G	–	–	–
	X13716N	16	5¾	1	V81.2	5	C10	5
	X13A16Y	14	5	1	T7	4	R3	–
	X11N16Y		8	1	D34	4	C87	–
	X11816Y		6	1	R5	–	R3	–
	X12016N		8	1	K6	–	R3	–
	X14A16Y		8	1	J4	17	C6	6
	X14D16Y		8	1	J5	17	C5	6
	P20B16N	1	7	1	M8	5	M3	5
	X12716N	1	2	1	S30	4	S30	4
	X12J16N	16	2	1	S30	4	S30	4
	X12D16N	12	6	3	J4	9	J5	9
	X10916C	16	8	1	M9	5	M2	5
	P10L16	1	7	1	M6	5	M2	5
	P4N16		7¾	1	K20	10	K27	10
	P4M16		7¾	1	K10	10	K26	10
	L6A16		14	1	J3	5	CB2	5
	K9D16		7¾	1	K10	10	W26	10
	K9C16		7¾	1	K26	10	W27	10
239	V10D16Y		13¾	1	S24.2	8	M7	5
238	D10A16		12¾	1	S24.4	8	M7	5
237	D10S16		11	1	S24.24	8	M6	5
236	D10A16		9½	1	S24.16	8	M6	5
235	L10T416		37¾	1	D5.10	4	J1.P	–
234	E3E16	1	23	1	M9	5	J2.K	–
233	F2B16	16	17½	1	M3	5	J2.H	–
232	P2M20N	20	5¾	18	DS8.1	–	DS4.1	–
231	P4M20		5¾	18	DS2.3	–	DS4.3	–
230	P4M20		9½	18	DS2.3	–	DS3.3	–
229	P2M20N	20	8	18	DS2.1	–	DS3.1	–
228	K23A16	16	29	1	S30	4	J2.B	–
227	K2A16		24¾	1	S30	4	J2.Y	–
226	K22A16		24½	1	S30	4	J2.Z	–
225	V10316N		15¼	1	S30	4	M8	–
224	V10716N		16½	1	T7.2	4	M8	–
223	K12A16		30¼	1	R18	–	J2.L	–
222	P15A16		23¾	1	J14	4	J2.D	–
221	V12A16A		29½	1	C67	–	J2.Z	–
220	X14D16Y	16	23¼	1	S29	4	J1.O	–
219	P2A20N	20	22½	18	DS6.1	–	D37	–
218	P2R20N		11	18	DS5.1	–	DS3.1	–
217	P2Y20N		8	18	DS5.1	–	DS6.1	–
216	P4F20		9	18	DS2.3	–	DS6.3	–
215	P4N20	20	11	18	DS3.3	–	DS3.3	–
214	P3A16	16	23½	2	C83	5	M4	6
213	P13J16		22¾	3	CB2	5	J2.F	–
212	E3B16	16	19¼	1	M2	5	J2.E	–
211	P4B16		23	1	M4	5	CB2	4
210	P10G16		16½	1	M9	5	CR16	–
209	P8A16		21	1	S28	4	J1.C	–
208	P13J16		33	1	S28	4	M4	5
207	P3C16		7	1	S28	4	S27	4
206	Q2F16		15	1	S13	4	CR17	–
205	Q2A16		2½	1	S13	4	J2.R	–
204	Q1A16		11	1	S13	4	S27	4
203	M3B16	1	20½	1	S13	4	J2.Y	–
202	M15E16	16	23	1	S13	4	J2.W	–
201	P1C16	14	23¼	2	S13	4	CR3	5
200	V19A16Y	1	24	2	S18	4	J2.T	–
199	J1468D16Y	1	24½	2	S18	4	J1.N	–
198	X14516Y	14	29¼	2	S18	4	S19	4
197	J1446A16Y	16	23¾	1	S18	4	J2.M	–
196	L10A16	1	28¾	1	S20	4	J2.B	–
195	L11A16		27¾	1	S20	4	J2.R	–
194	K31A16		27½	1	S20	4	J2.E	–
193	V12F16Y		37	1	S20	4	S30	4
192	T12E16Y		29¾	1	S20	4	J1.B	–
191	V10J16C		4½	1	S20	4	T7.1	4
190	X12N16N	1	49½	1	D30	4	T7.2	4
189	L10S816	16	31¾	1	D5.10	4	J1.V	–
188	P4T20	20	4¾	18	D54.1	–	D55.3	–
187	P4N20	20	4½	18	D54.3	–	S10	4
186	L1A16	16	49	1	D37	–	S10	4
185	P2K20N	20	4¾	18	D54.1	–	D55.3	–
184	P2R20N	20	4¾	18	D54.1	–	D55.3	–
183	P2T16N	16	5½	1	D27	–	D38	–
182	L18A16		4¾	1	D28	–	D5.10	4
181	L10A816		46	1	D58	–	S10	4
180	L10J416		25½	1	D31	4	J1.K	–
179	X13D16Y		40	1	D58	4	S20	4
178	X10C16B		51¾	1	S24.3	8	J1.S	–
177	X10E16A		51½	1	S24.23	8	J1.U	–
176	X10316C	1	32½	1	S24.21	8	J1.W	–
175	X12M16N	16	45¾	1	S24.15	8	DS10	4

FIND NO.	WIRE NO.	WIRE SIZE (AWG)	WIRE LENGTH (IN.)	WIRE ITEM NO. (SEE LIST OF MATL)	FROM	LUG ITEM NO. (SEE LIST OF MATL)	TO	LUG ITEM NO. (SEE LIST OF MATL)
248	U12	12	12	3	J2.U	–	–	–
247	O12	12	12	3	J2.O	–	–	–
246	K16	16	12	1	J2.K	–	–	–
245	H16	16	12	1	J2.H	–	–	–
244	F16	16	12	1	J2.F	–	–	–

EQPT SYM	QTY	NOMENCLATURE	CODE IDENT	IDENTIFYING NO	SPECIFICATION	MATERIAL	UNIT WT	CONT	ITEM NO.
		LIST OF MATERIALS							
		WIRE, ELEC, AIRCRAFT		MS25190-A-20	MIL-W-5086A				15
	1	LUG, CRIMP STYLE, INS	98410	BB-519-10					17
		SOLDER		60-M-S-71, 1/16Ø	MIL-S-6872				18
		TY-RAP, SELF-CLINCHING		MS37821-1-0	MIL-T-7928				19
		TY-RAP, SELF-CLINCHING		MS37821-4-0	MIL-T-7928				14
	1	CONNECTOR, ELECTRICAL		MS3100A32-7P			J2		13
	1	CONNECTOR, ELECTRICAL		MS3100A36-7P			J1		12
	1	LUG, CRIMP STYLE, INS		MS25036-12	MIL-T-7928				11
	18	CONNECTOR, FEMALE	59730	KB 250					10
	1	LUG, CRIMP STYLE, INSULATED	98410	C-518-10					9
	14	LUG, CRIMP STYLE, INSULATED	98410	B-507-06					8
	18	LUG, CRIMP STYLE, INSULATED		MS25036-54	MIL-T-7928				7
	14	LUG, CRIMP STYLE, INSULATED		MS25036-8	" " "				6
	43	LUG, CRIMP STYLE, INS		MS25036-53	" " "				5
	2-42	LUG, CRIMP STYLE, INS		MS25036-6	" " "				4
	12	WIRE, ELEC, AIRCRAFT		MS25190-A-12	MIL-W-5086A				3
	60	WIRE, ELEC, AIRCRAFT		MS25190-A-16	" " "				2
	SHT	WIRE, ELEC, AIRCRAFT		MS25190-A-16	" " "				1

NOTES:
1. ALL CONDUCTOR ENDS TO BE STRIPPED .50 IN. AND TINNED BEFORE ASSY.
2. MARK ALL WIRES PER MIL-W-5088.
3 REF. WIRING DIAGRAM 69P38110.

Figure 2-4A. Control Box Wiring Harness and Cutting List

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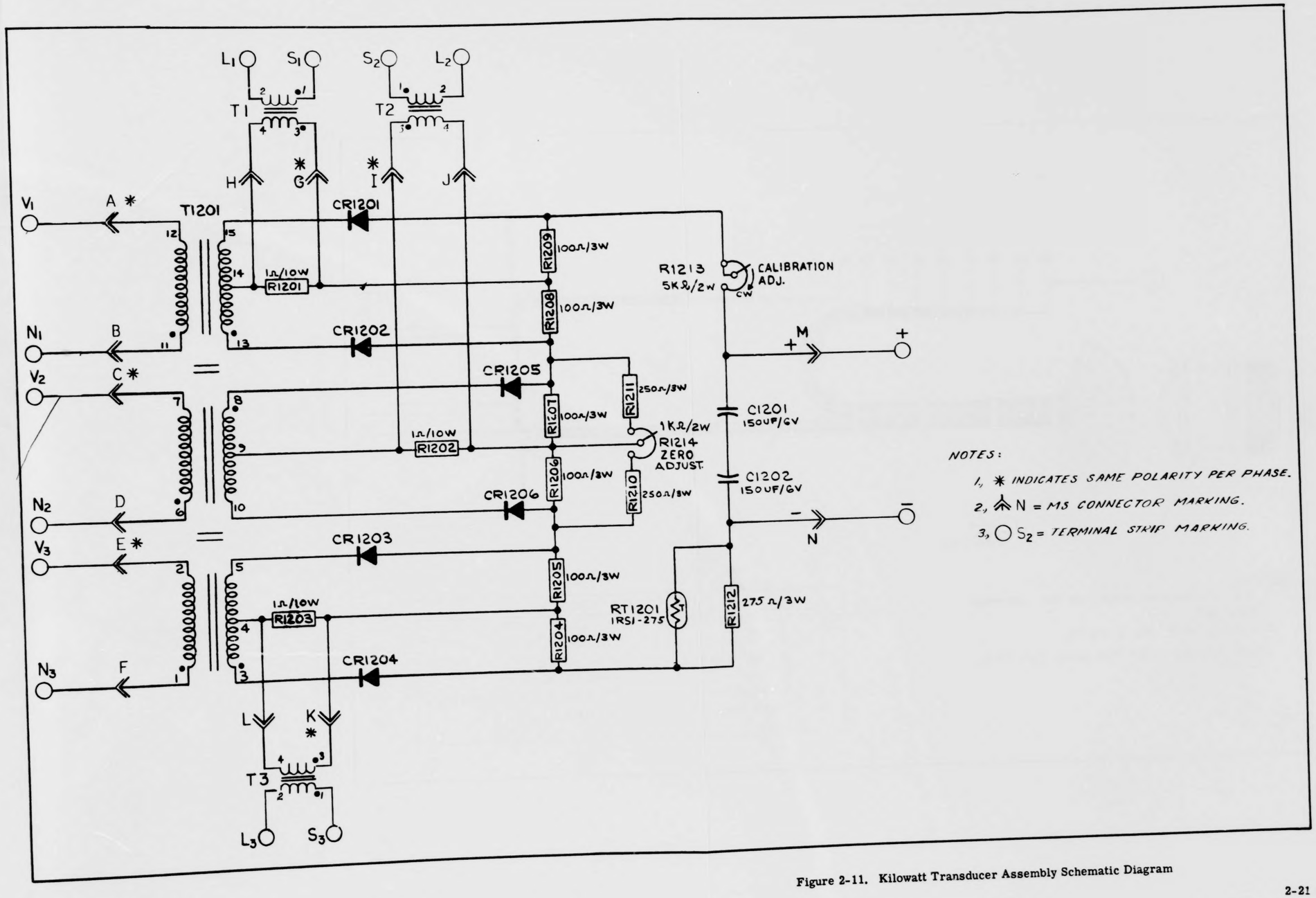

NOTES:

1, * INDICATES SAME POLARITY PER PHASE.

2, N = MS CONNECTOR MARKING.

3, S_2 = TERMINAL STRIP MARKING.

Figure 2-11. Kilowatt Transducer Assembly Schematic Diagram

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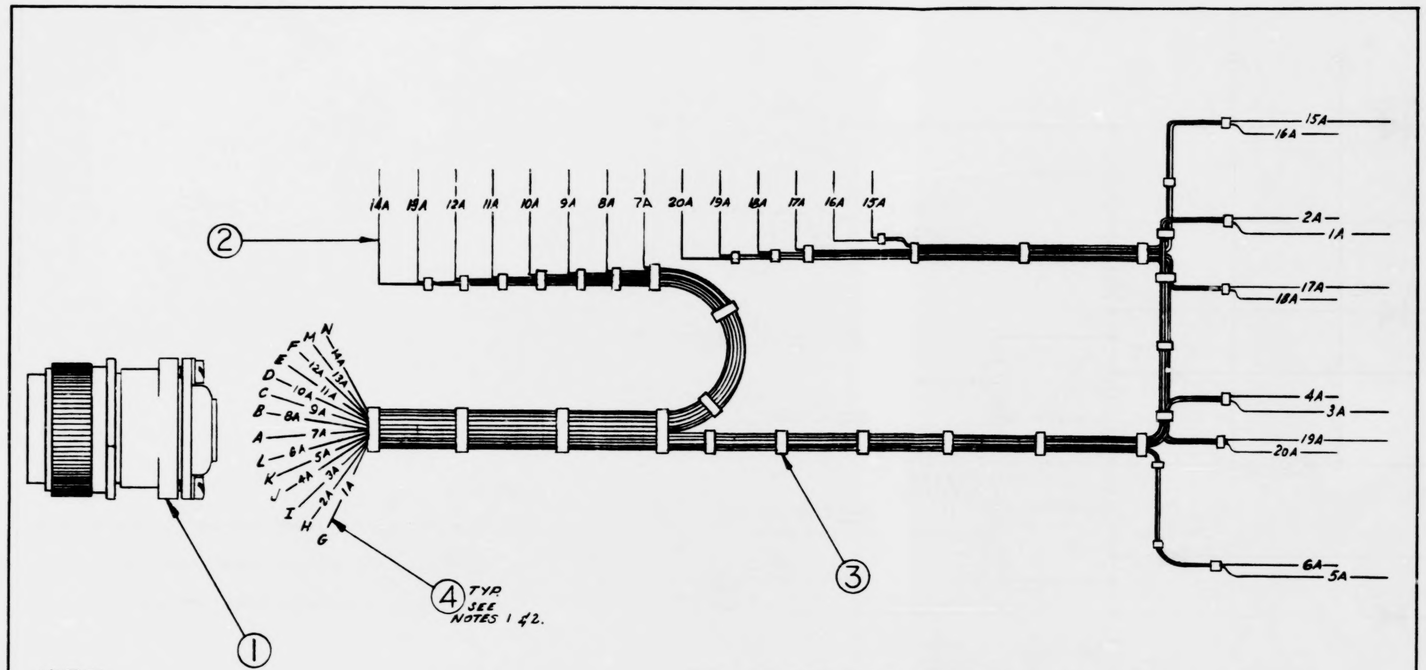

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 1/2".
2. SOLDER PER MIL-S-6872.
3. SEE FIGURE 2-12A FOR WIRE CUTTING LIST.

LIST OF MATERIALS

ITEM	PART NO.	DESCRIPTION
1	MS 3106R-20-27S	CONNECTOR
2	S980-4048-0	WIRE, 135°C AWG 20 BLACK
3	S365-8001	TY-RAP SELF-CLINCHING
4	S958-0001	SOLDER

Figure 2-12. Kilowatt Transducer Assembly Harness

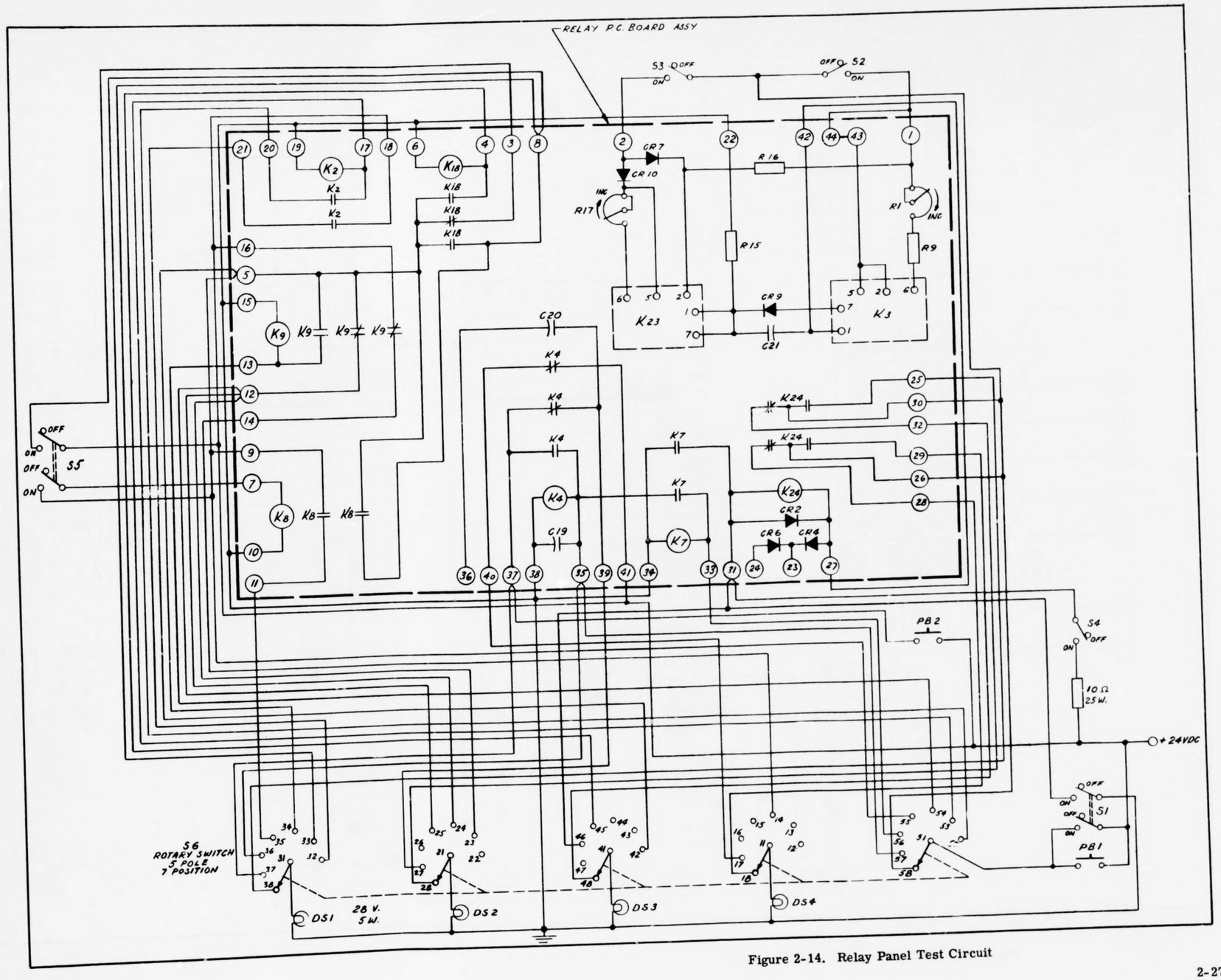

Figure 2-14. Relay Panel Test Circuit

Reproduced from poor document.

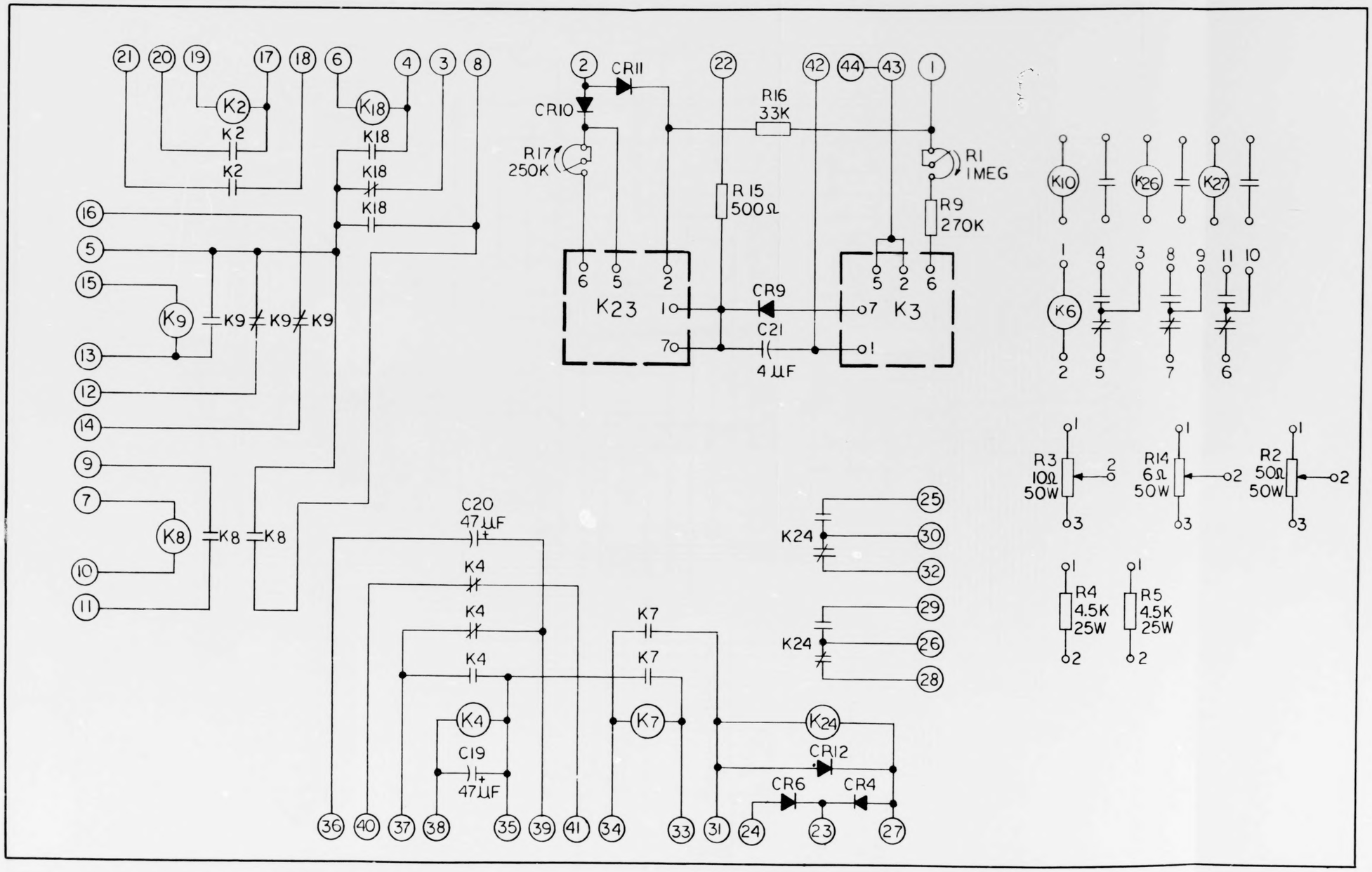

Figure 2-15. Relay Panel Schematic Diagram

Legend To Figure 2-17

1. Harness Assembly
2. External Washer Nut
3. Potential Transformer
4. External Washer Nut
5. Terminal Board
6. External Washer Nut
7. Voltage Regulator
8. Assembled Washer Screw
9. Cover Assembly
10. Diode Semiconductor Device
11. Diode Semiconductor Device
12. Cover
13. Screw, nut
14. Component Board Assembly
15. Electrical Retainer
16. Magnetic Amplifier
17. Electrical Retainer
18. Armature Relay
19. Fixed Resistor
20. Diode Semiconductor Device
21. Fixed Capacitor
22. Electrical Retainer
23. Diode Semiconductor Assy.
24. Fixed Resistor
25. Fixed Resistor
26. Electrical Retainer
27. Fixed Capacitor
28. Fixed Resistor
29. Fixed Resistor
30. Fixed Resistor
31. Fixed Resistor
32. Diode Semiconductor Device
33. Electrical Retainer
34. Fixed Capacitor
35. Component Board
36. Identification Plate
37. Variable Resistor
38. Variable Resistor
39. Screw, nut
40. Terminal Board
41. Screw, washer, nut
42. Fixed Resistor
43. Screw, nut
44. Reactor
45. Screw, nut
46. Transformer
47. Chassis
48. Mounting Plate

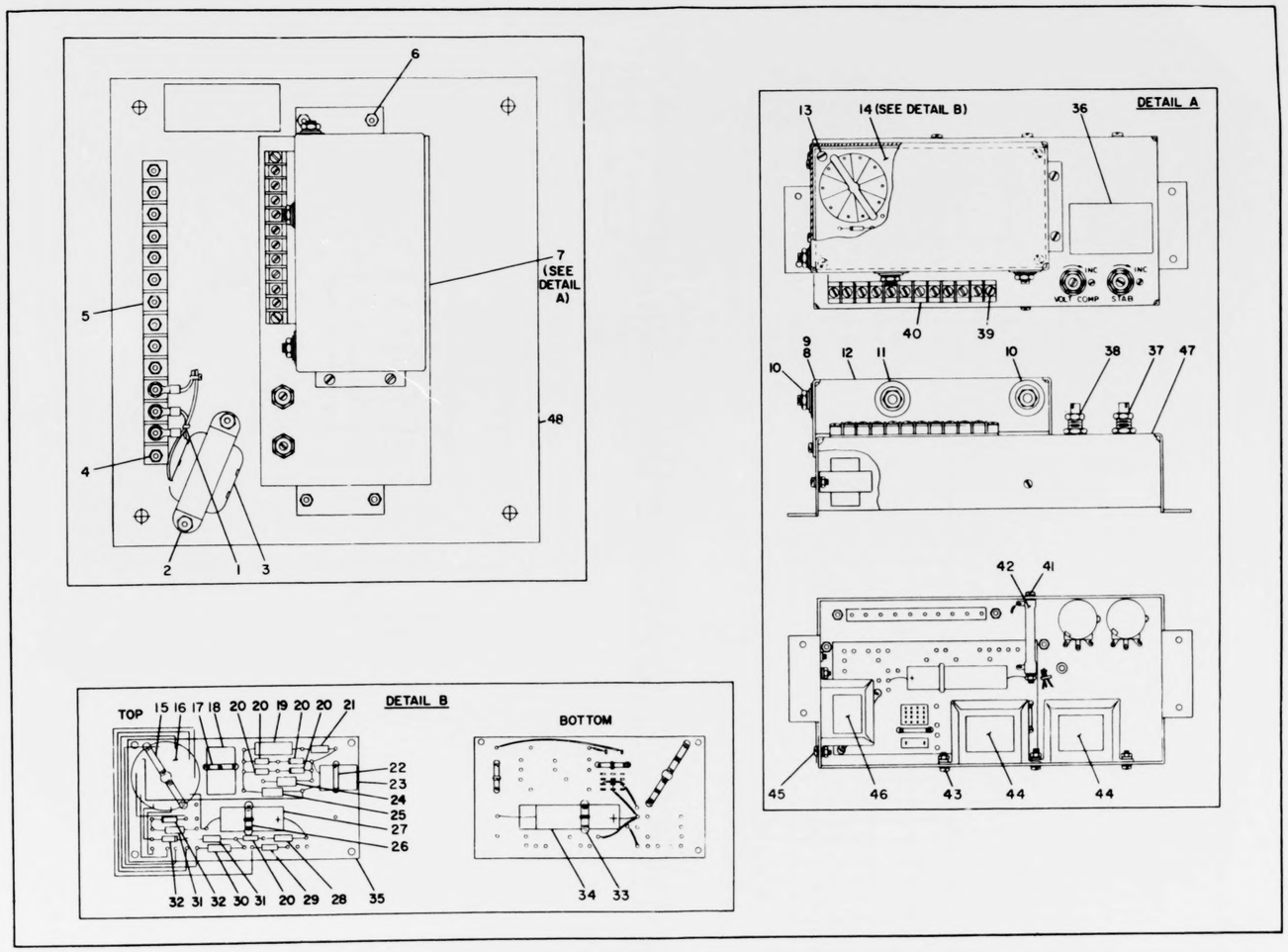

Figure 2-17. Voltage Regulator Assembly

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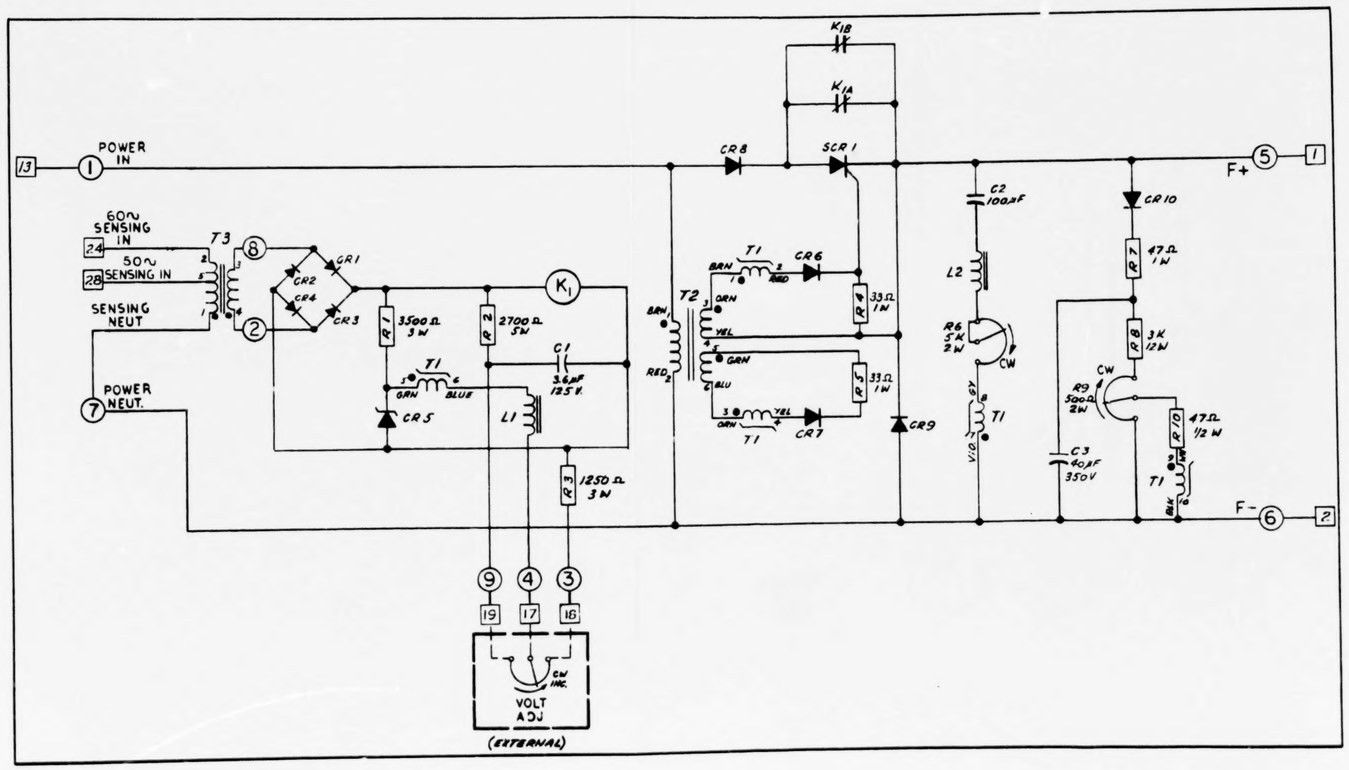
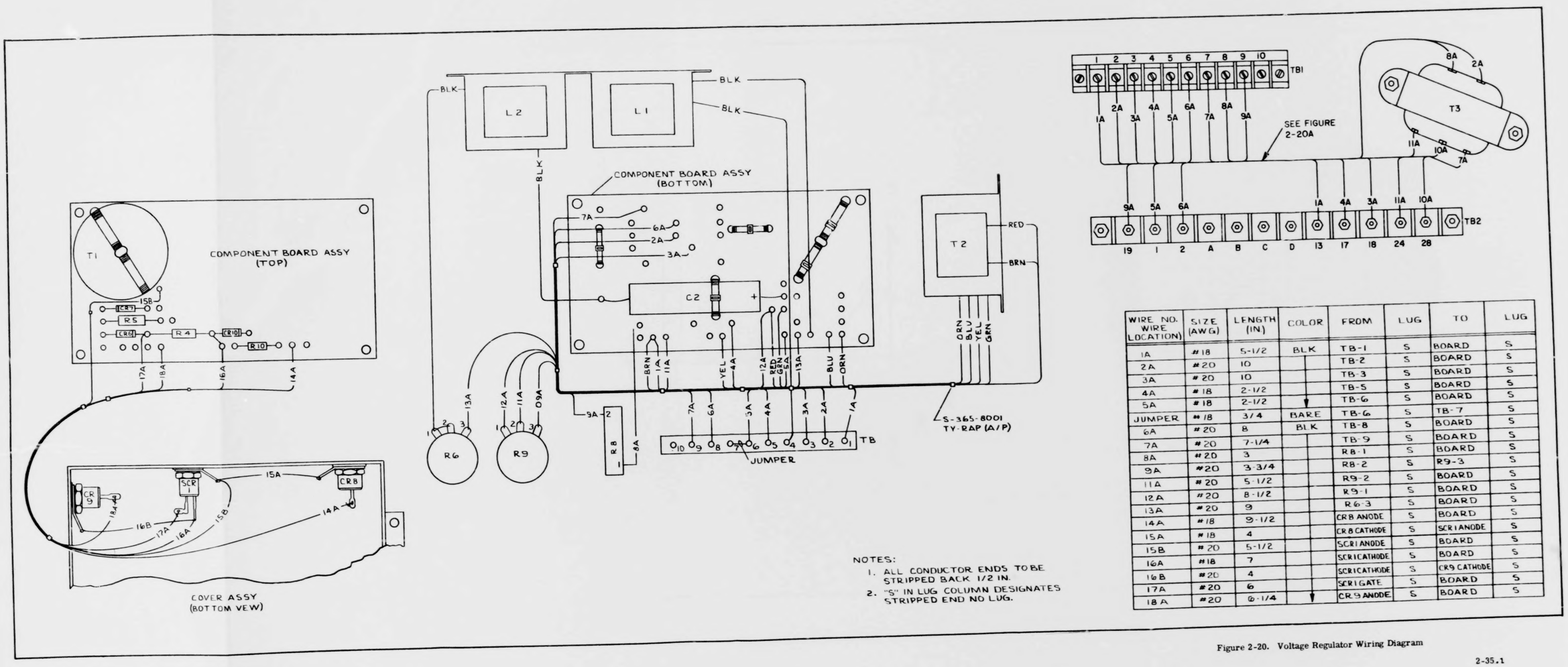


Figure 2-19. Voltage Regulator Schematic Diagram

Reproduced from poor document.



WIRE NO. WIRE LOCATION)	SIZE (AWG)	LENGTH (IN)	COLOR	FROM	LUG	TO	LUG
1A	#18	5-1/2	BLK	TB-1	S	BOARD	S
2A	#20	10		TB-2	S	BOARD	S
3A	#20	10		TB-3	S	BOARD	S
4A	#18	2-1/2		TB-5	S	BOARD	S
5A	#18	2-1/2		TB-6	S	BOARD	S
JUMPER	#18	3/4	BARE	TB-6	S	TB-7	S
6A	#20	8	BLK	TB-8	S	BOARD	S
7A	#20	7-1/4		TB-9	S	BOARD	S
8A	#20	3		RB-1	S	BOARD	S
9A	#20	3-3/4		RB-2	S	R9-3	S
11A	#20	5-1/2		R9-2	S	BOARD	S
12A	#20	8-1/2		R9-1	S	BOARD	S
13A	#20	9		R6-3	S	BOARD	S
14A	#18	9-1/2		CR8 ANODE	S	SCR1ANODE	S
15A	#18	4		CR8 CATHODE	S	BOARD	S
15B	#20	5-1/2		SCR1ANODE	S	BOARD	S
16A	#18	7		SCR1CATHODE	S	CR9 CATHODE	S
16B	#20	4		SCR1CATHODE	S	BOARD	S
17A	#20	6		SCR1GATE	S	BOARD	S
18A	#20	6-1/4		CR9 ANODE	S	BOARD	S

NOTES:
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 1/2 IN.
2. "S" IN LUG COLUMN DESIGNATES STRIPPED END NO LUG.

Figure 2-20. Voltage Regulator Wiring Diagram

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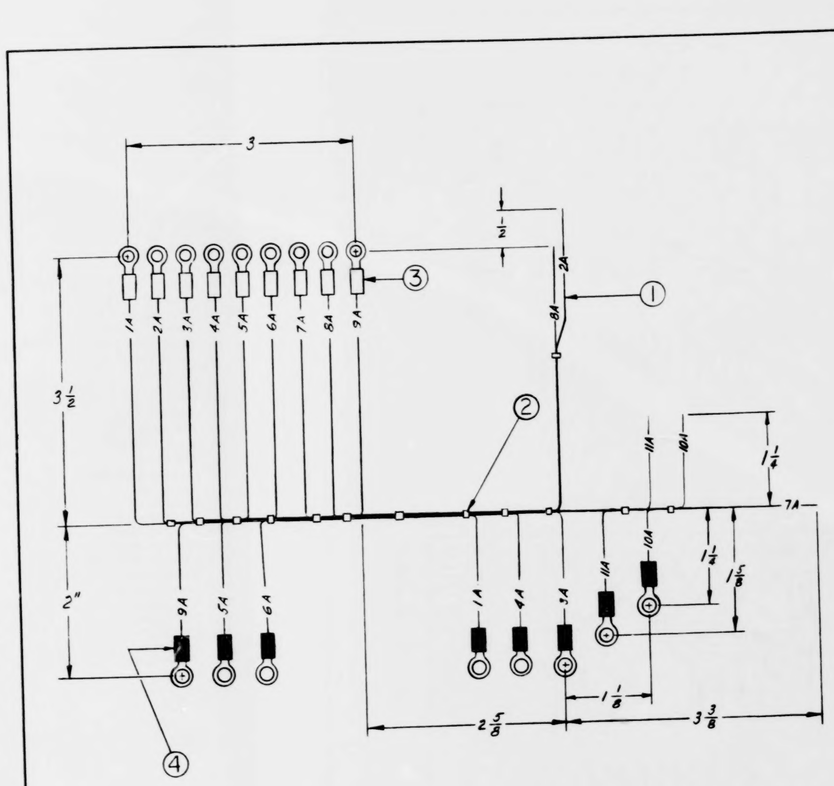

WIRE NO. (WIRE LOCATION)	SIZE (AWG)	LENGTH (IN.)	COLOR	FROM	LUG	TO	LUG
1A	#18	9-1/2	BLACK	TB1-1	S-979-0008	TB2-13	S-979-0009
2A		12-1/4		TB1-2	-0008	T3-4	S
3A		10		TB1-3	-0008	TB2-18	S-979-0009
4A		9		TB1-4	-0008	TB2-17	-0009
5A		5-1/2		TB1-5	-0008	TB2-1	-0009
6A		5		TB1-6	-0008	TB2-2	-0009
8A		9-3/4		TB1-8	-0008	T3-3	S
9A		7-1/2		TB1-9	-0008	TB2-19	S-979-0009
10A		2-3/4		T3-5	S	TB2-28	-0009
11A		3-1/4		T3-2	S	TB2-24	-0009
7A	#18	10	BLACK	T3-1	S	TB1-7	-0008

SUMMATION

S-980-4049-0 84-1/2"
S-979-0008 9
S-979-0009 8

NOTES:
1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 1/2 IN.
2. "S" IN LUG COLUMN DESIGNATES STRIPPED END NO LUG.

Figure 2-20A. Voltage Regulator Wiring Harness and Cutting List

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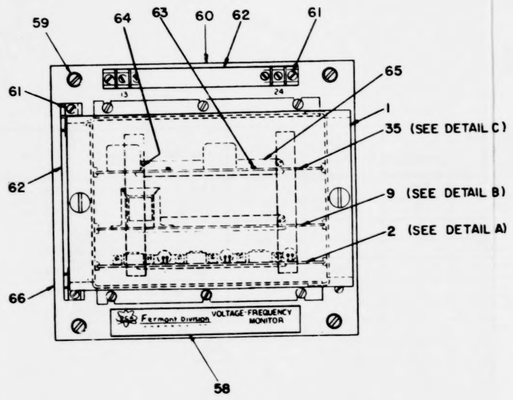

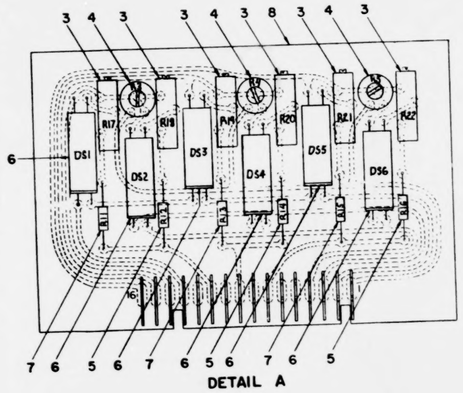

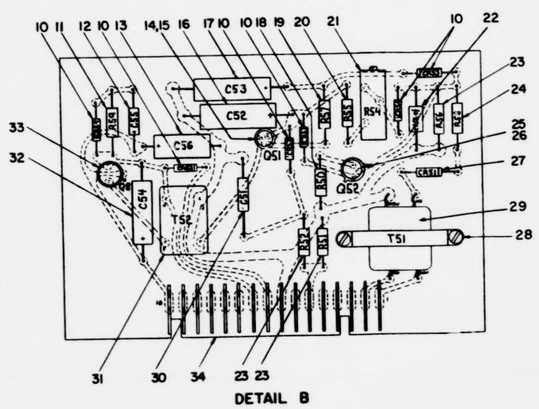

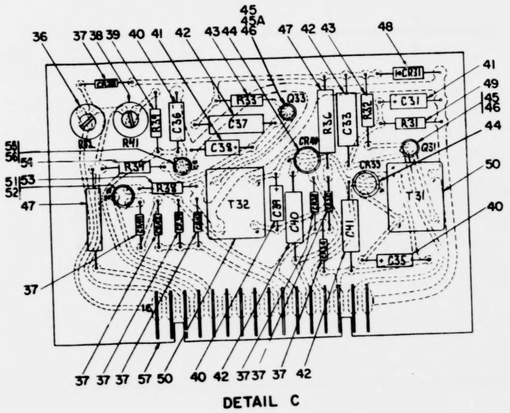

Figure 2-21. Voltage and Frequency Monitor Assembly

Legend To Figure 2-21.

1. Card Rack Cover
2. Sensing Unit Circuit Card Assy.
3. Variable Resistor
4. Variable Resistor
5. Fixed Resistor
6. Photo Semi Conductor Device
7. Fixed Resistor
8. PC Board
9. Frequency Circuit Card Assy.
10. Diode Semiconductor Device
11. Fixed Resistor
12. Fixed Capacitor
13. Fixed Capacitor
14. Transistor
15. Insulating Washer
16. Capacitor
17. Capacitor
18. Fixed Resistor
19. Fixed Resistor
20. Fixed Resistor
21. Variable Resistor
22. Diode Semiconductor Device
23. Fixed Resistor
24. Fixed Resistor
25. Transistor
26. Insulating Washer
27. Diode Semiconductor Device
28. Assembled Washer Screw, Nut
29. Transformer
30. Fixed Capacitor
31. Transformer
32. Capacitor
33. Diode Semiconductor Device
34. PC Board
35. Switching Circuit Card Assy.
36. Variable Resistor
37. Diode Semiconductor Device
38. Variable Resistor
39. Fixed Resistor
40. Fixed Capacitor
41. Fixed Capacitor
42. Capacitor
43. Fixed Resistor
44. Diode Semiconductor Device
45. Insulating Washer
45A. Transistor
46. Insulating Washer
47. Fixed Resistor
48. Diode Semiconductor Device
49. Fixed Resistor
50. Pulse Transformer
51. Transistor
52. Insulating Washer
53. Fixed Resistor
54. Fixed Resistor
55. Transistor
56. Insulating Washer
57. PC Board
58. Identification Plate
59. Screw, Lockwasher, Spacer
60. Main Circuit Card Assembly
61. Assembled Washer Screw, Nut
62. Terminal Board
63. Insert Polarization
64. Assembled Washer Screw, Nut
65. PC Card Receptacle
66. Main PC Board

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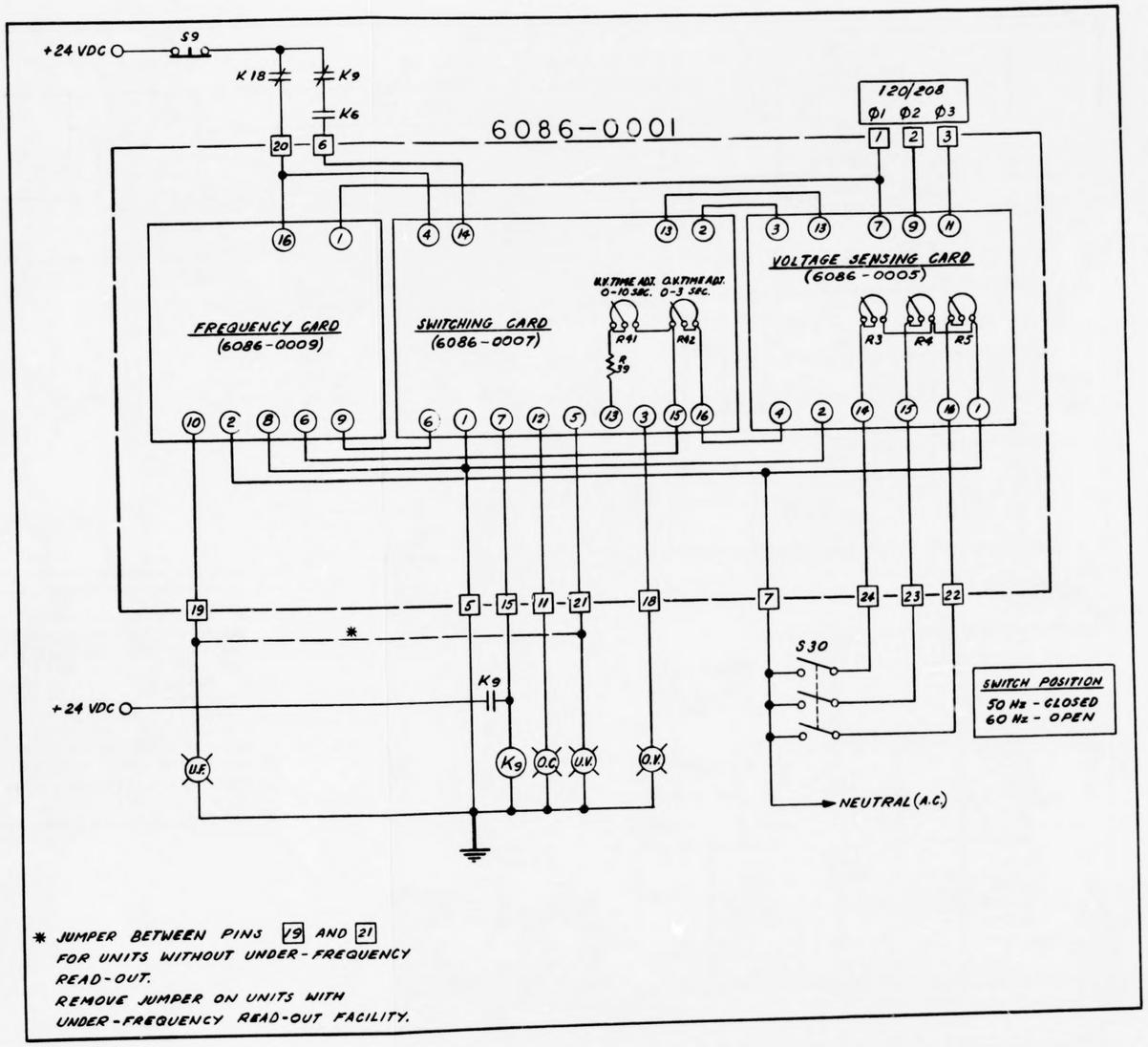
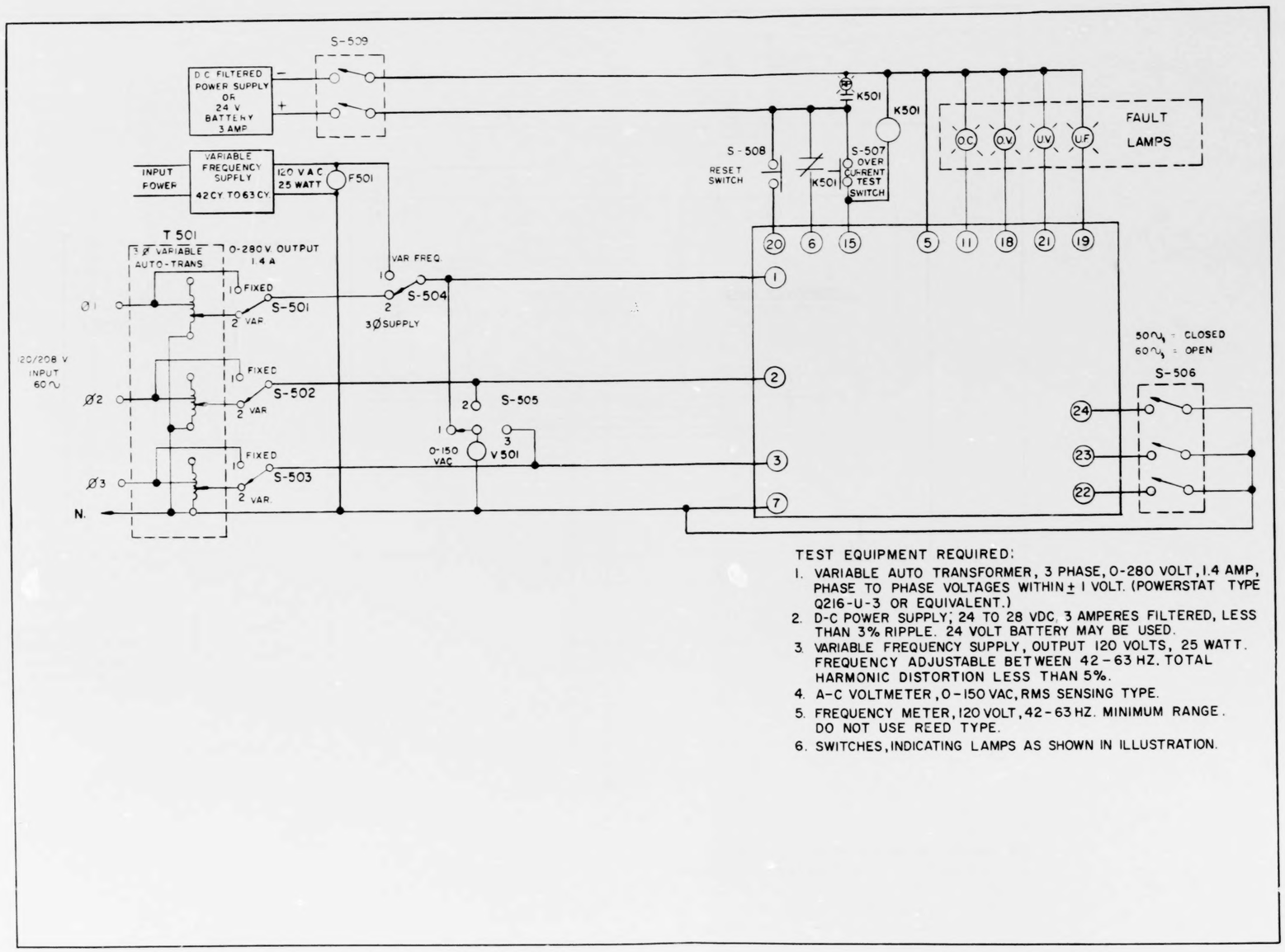


Figure 2-21A. Voltage and Frequency Monitor Interconnect Wiring



TEST EQUIPMENT REQUIRED:

1. VARIABLE AUTO TRANSFORMER, 3 PHASE, 0-280 VOLT, 1.4 AMP, PHASE TO PHASE VOLTAGES WITHIN ± 1 VOLT. (POWERSTAT TYPE Q216-U-3 OR EQUIVALENT.)
2. D-C POWER SUPPLY; 24 TO 28 VDC. 3 AMPERES FILTERED, LESS THAN 3% RIPPLE. 24 VOLT BATTERY MAY BE USED.
3. VARIABLE FREQUENCY SUPPLY, OUTPUT 120 VOLTS, 25 WATT. FREQUENCY ADJUSTABLE BETWEEN 42 - 63 HZ. TOTAL HARMONIC DISTORTION LESS THAN 5%.
4. A-C VOLTMETER, 0 - 150 VAC, RMS SENSING TYPE.
5. FREQUENCY METER, 120 VOLT, 42 - 63 HZ. MINIMUM RANGE. DO NOT USE REED TYPE.
6. SWITCHES, INDICATING LAMPS AS SHOWN IN ILLUSTRATION.

Figure 2-22. Voltage and Frequency Monitor Test Set Schematic Diagram

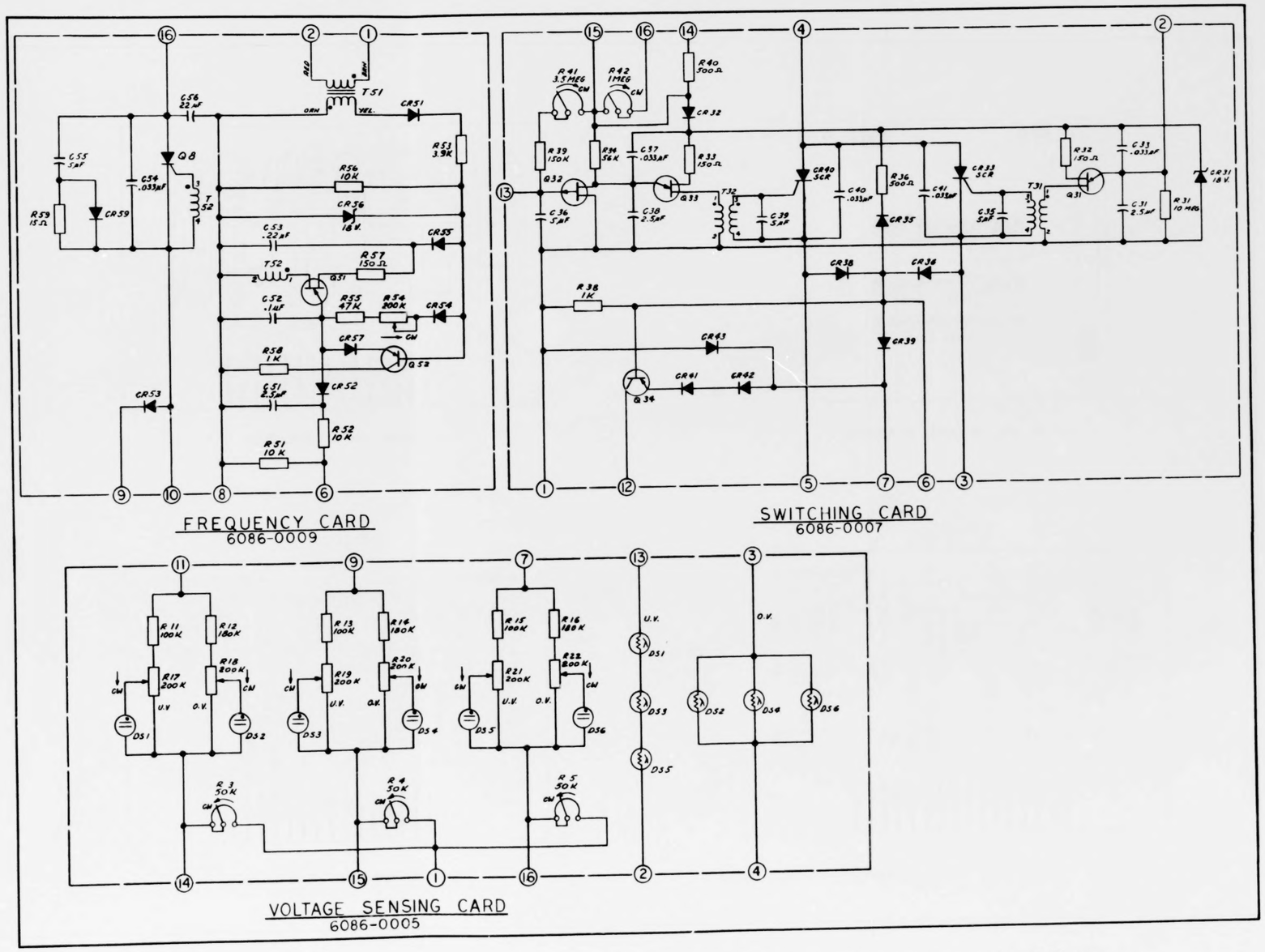


Figure 2-23. Voltage and Frequency Monitor Schematic Diagram

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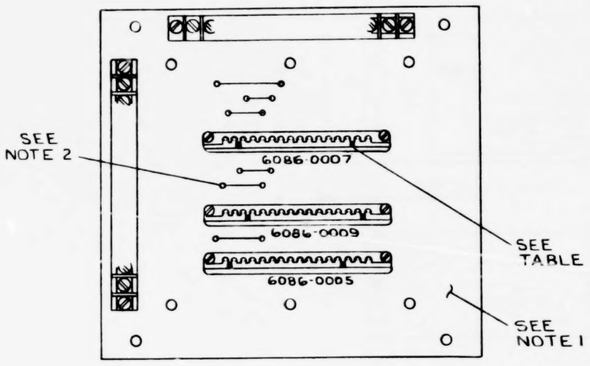
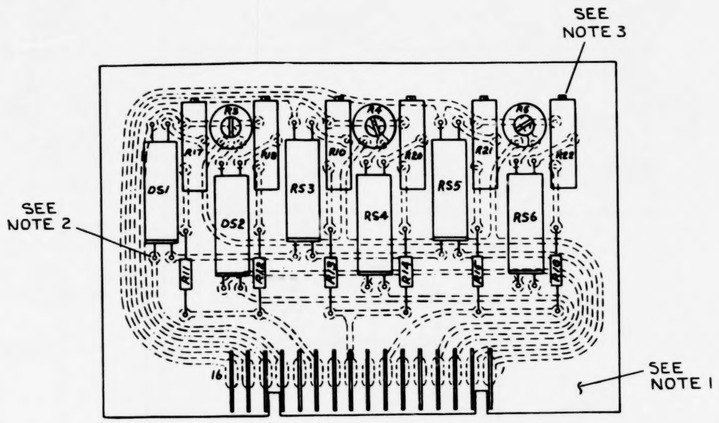


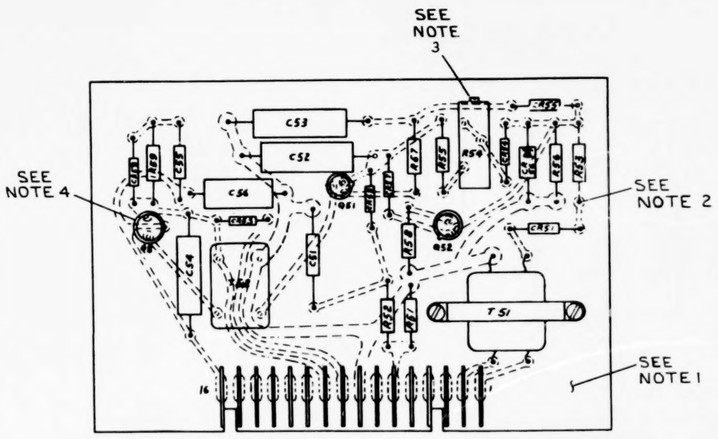
MAIN PC BOARD ASSEMBY



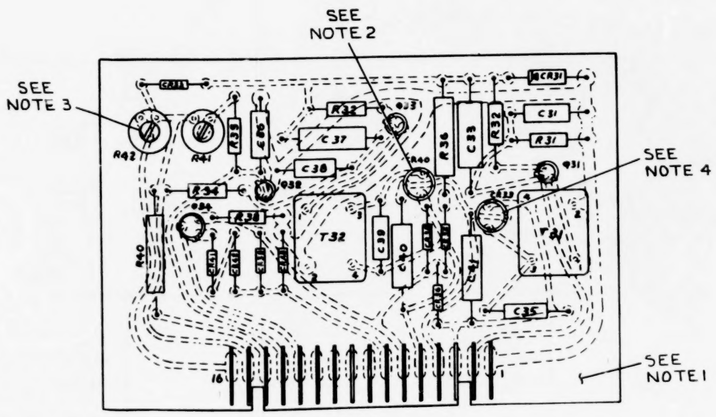
SENSING UNIT ASSEMBLY

POLARIZATION INSERT LOCATION TABLE	
IDENTIFICATION NO.	POSITTION (BETWEEN PINS)
6086-0005	1 & 2; 13 & 14
6086-0007	2 & 3; 14 & 15
6086-0009	3 & 4; 15 & 16

NOTES:
1. INSULATING COMPOUND-APPLY ONE COAT PER MIL-I-46058, CLASS A-AFTER TEST.
2. SOLDER PER MIL-S-6872
3. GLYPTAL ALL POT ADJUSTMENTS AFTER CALIBRATION
4. INDICATES ANODE OF SCR (ANODE LEAD CONNECTED TO CASE).



FREQUENCY UNIT ASSEMBLY



SWITCHING UNIT ASSEMBLY

Figure 2-24. Voltage and Frequency Monitor Wiring Diagram

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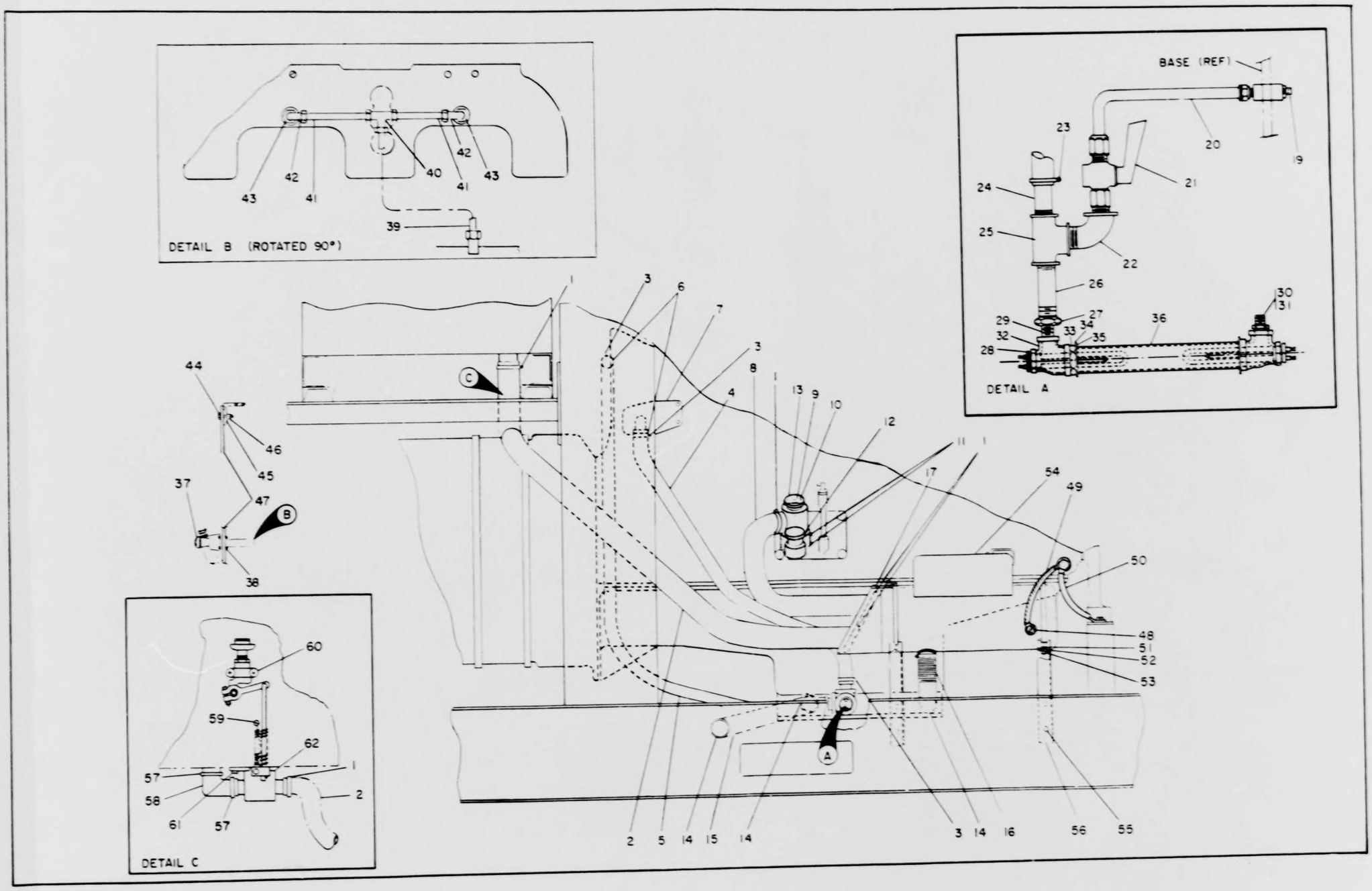

Figure 2-36. Winterization Assembly

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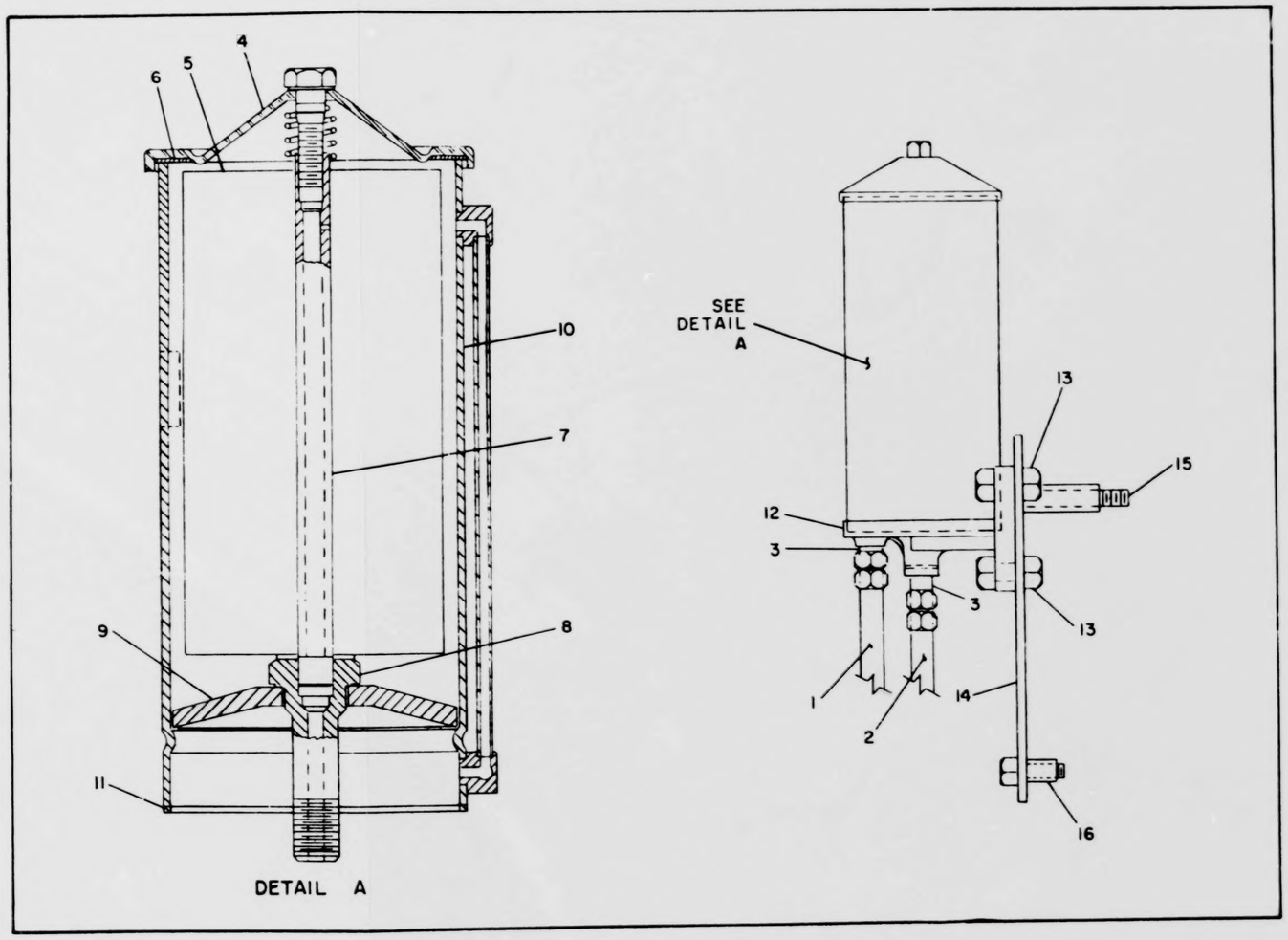

1. Pump to Filter Line Assembly
2. Filter to Pan Line Assembly
3. Connector
4. Cover Assembly
5. Filter Element
6. Cover Gasket
7. Center Tube
8. Retaining Plate
9. Shell Retaining Plate
10. Shell Assembly
11. Shell Gasket
12. Base
13. Hex. Hd Cap Bolt
14. Plate
15. Hex. Hd Cap Bolt
16. Hex. Hd Cap Bolt

Figure 2-46. Lubricating Oil Filter Assembly

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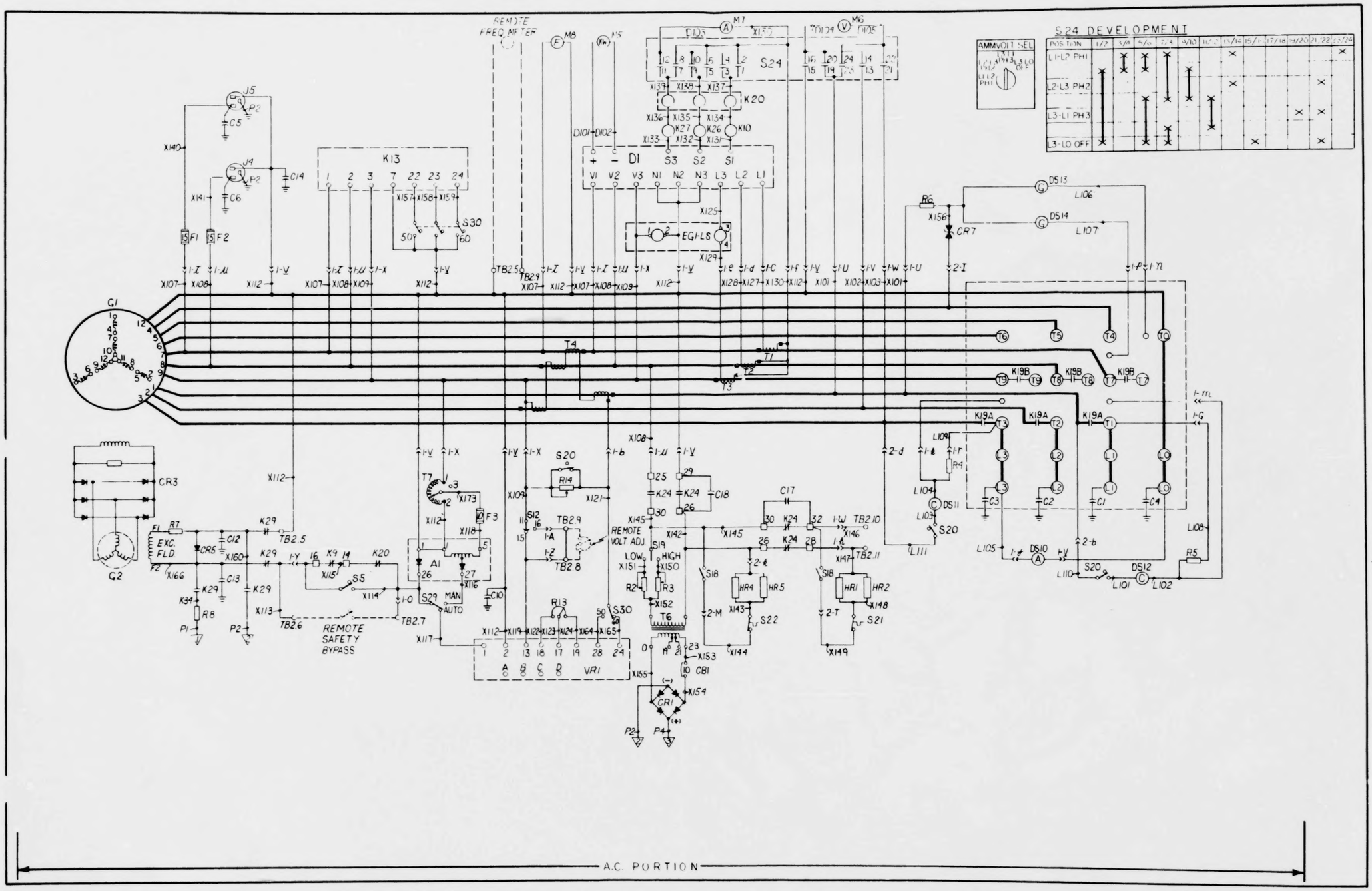

Figure 3-2. Schematic Diagram (Sheet 1 of 3)

Reproduced from poor document.

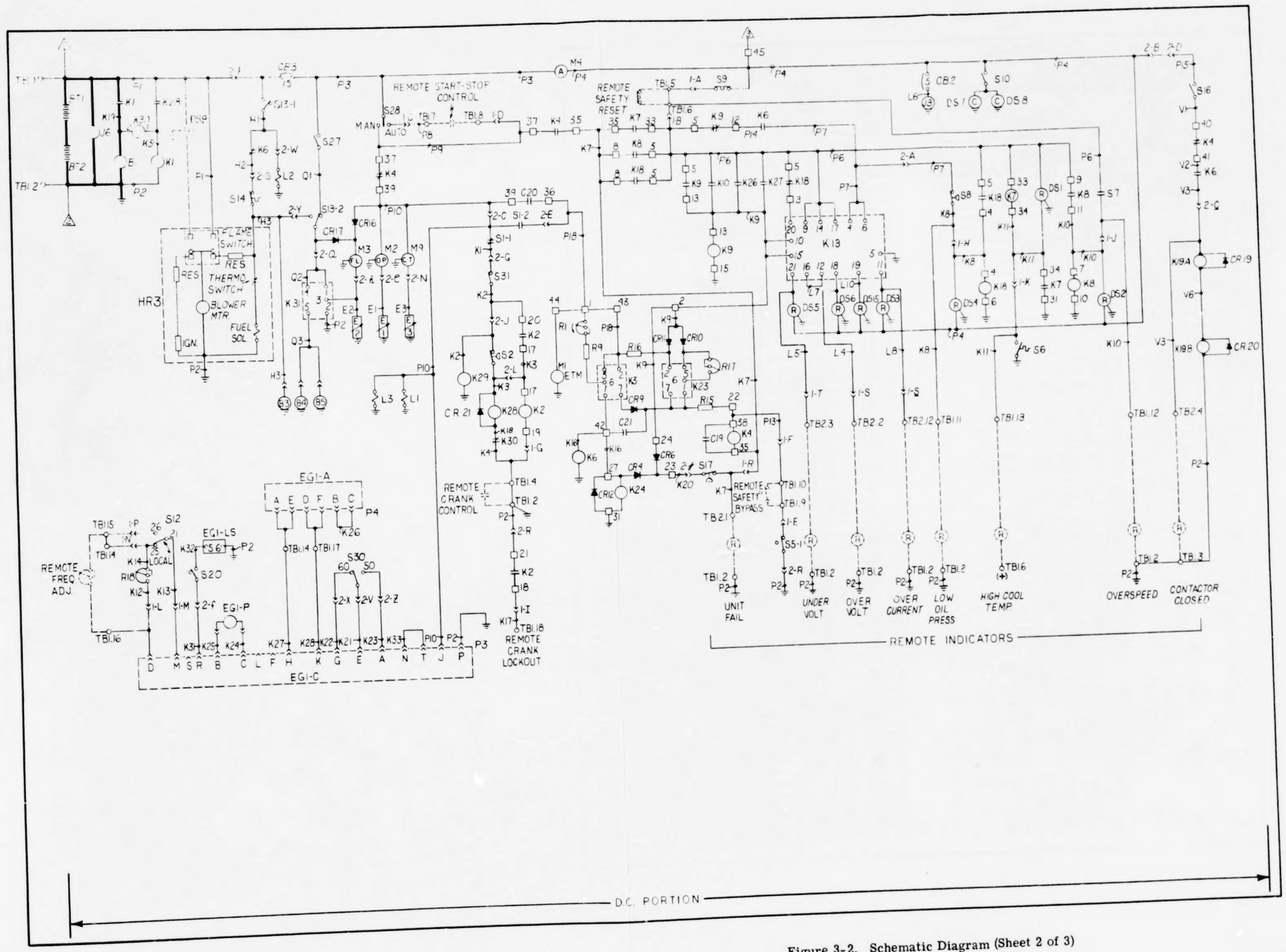

Figure 3-2. Schematic Diagram (Sheet 2 of 3)

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SYM	PART NO	DESCRIPTION
K20	C52-1091	RELAY, OVERLOAD
K19 A&B	C52-1166-4	CONTACTOR, LOAD
K18	B07A613BC1-0034	RELAY, FAULT, LOW OIL PRESS.
K13	69C38160	RELAY, MONITOR, U.V. O.V. & UNDER FREQ.
K10	B52-1066	RELAY, SHORT CKT. PH 1
K9	B07A613BC1-0034	RELAY, ELECT. FAULT LOCKOUT
K8	B07A613BC1-0034	RELAY, FAULT, OVERSPEED
K7	B07A613BC1-0034	RELAY, FAULT, HIGH COOL TEMP.
K6	5715-52HS	RELAY, ENG. RUN
K4	B07A613BC1-0034	RELAY, FAULT, SHUTDOWN
K3	69C38177	RELAY, TIME DELAY, 10SEC (STATIC)
K2	B07A613BC1-0034	RELAY, ENG. START
K1	———	CONTACTOR, STARTER MTR
J6	4485077	RECP, EXT. POWER, 24V
J5	B52-1074	RECP, CONV.
J4	B52-1073	RECP, CONV.
J3	B52-1070	RECP, TROUBLE LIGHT
J2	MS3100A-32-7P	RECP, CONTROL BOX
J1	MS3100A-36-7P	RECP, CONTROL BOX
HR4,5	A52-1115	HTR, STRIP, BATT. BOX
HR3	D52-1093	HTR, FUEL BRNG.
HR1,2	B52-1097-4	HTR, IMMERSION, COOL & LUBE OIL
G2	PART OF G1	EXC, GEN.
G1	B52-1206	GEN., MAIN
F3	MS90079-5	FUSE, MAN. VOLT CONTROL 10A 250V
F1, 2	MS90082-6	FUSE, CONV. RECEPT. 15A
EGI-P	69H38208	MAG. PICK UP, ELECT. GOV.
EGI-LS	69C38183	LOAD SHARING, ELECT. GOV.
EGI-C	69C38205-02	COMPUTER, ELECT. GOV.
EGI-A	69C38207	ACTR, ELECT. GOV.
E3	1513355	XMTR, COOLANT TEMP.
E2	C52-189	XMTR, FUEL LEVEL
E1	B52-1122	XMTR, OIL PRESS.
DS15	MS35331-6	IND. LIGHT, UNDERFREQUENCY
DS13,14	6484256	IND. LIGHT, GEN. VOLT CONN.
DS11,12	B52-1054	SYNC. LIGHT
DS10	B52-1140	IND. LIGHT, LOAD TERM. ENERGIZED
DS9	MS35331-8	IND. LIGHT, FUEL BRN. HTR. ON (WHEN USED)
DS7,8	B52-1055	PANEL LIGHT
DS6	MS35331-6	IND. LIGHT, OVERVOLT
DS5	MS35331-6	IND. LIGHT, UNDERVOLT
DS4	MS35331-6	IND. LIGHT, LOW OIL PRESS.
DS3	MS35331-6	IND. LIGHT, OVERCURRENT
DS2	MS35331-6	IND. LIGHT, OVERSPEED
DS1	MS35331-6	IND. LIGHT, HIGH COOL TEMP.
DI	69C38179	CONVERTER, KILOWATT
CR19,20	69B38182	DIODE ASS'Y, LOAD CONTACTOR COIL
CR16,17,21	TA20	DIODE, BLOCKING
CR9,10,11,12	TA20	DIODE, STEERING
CR7	6484400	DIODE, ZENER
CR5	A52-1231	DIODE, FLYBACK
CR4,6	A52-1211	DIODE, BLOCKING
CR3	PART OF G1	RECTIFIER ASS'Y, GEN.
CR1	69C38199	RECTIFIER ASS'Y, BATT. CHG.
CB3	MS25017-15	CKT. BKR 15A. D.C.
CB2	MS25017-5	CKT. BKR, 5A TROUBLE LIGHT
CB1	MS25017-10	CKT. BKR, 10A BATT. CHG.
C21	118P05925S4	CAP, FIXED, COUPLING 47μFD 200V
C19,20	CSR13F476KM	CAP, FIXED, HOLDING 47μFD 35V
C13	CA32KF.B504	CAP, FIXED, RFI .5μFD 100V
C12	CA33KF.B504	CAP, FIXED, RFI .5μFD 100V
C17,18	CDS3BIEF205KI	CAP, FIXED, ARC SUPP. 2μFD 600V
C2,4,5,E14	CA37KFW104	CAP, FIXED, R.F.I. .1μFD 500V
C1,3,6,7,8,9,10	CA36KFW104	CAP, FIXED, R.F.I. .1μFD 500V
BT1,2	MS35001-5	BATT, 12V 8T
B4,5	MS51321-2	PUMP, FUEL, AUX SOURCE, 24V, 25 G.P.H.
B3	MS51321-2	PUMP, FUEL, 24V, 25 G.P.H.
B1	———	MTR, ENG STARTER
A1	B52-1082	TRANS & RECTIFIER ASS'Y.

SYM	PART NO	DESCRIPTION
VR1	69D38200	VOLTAGE REGULATOR ASSY.
T7	66A44135	TRANS, VAR. MAN. VOLT. ADJ.
T6	C52-1021	TRANS, POTENTIAL, BATT. CHG.
T4	B52-1220-3	TRANS, CROSS CURRENT COMP. 347/193
T1,2,3	B52-1220-4	TRANS, CURRENT 225/5
S31	MS35058-22	SW, TOGGLE, STARTER DISCONNECT
S30	3120316	SW, ROTARY, 50-60 HZ OPERATION
S29	MS35058-23	SW, TOGGLE, AUTO-MAN. VOLT REG SEL
S28	MS35058-21	SW, TOGGLE, ENG START-STOP
S27	MS35058-22	SW, TOGGLE, AUX. FUEL PUMP
S24	C52-1092	SW, ROTARY, AMM-VOLT SELECTOR
S22	A52-1114	SW, THERMAL, BATT BOX AMBIENT
S21	B52-1124	SW, THERMAL, COOLANT
S20	MS25068-23	SW, TOGGLE, PARALLEL
S19	MS35058-21	SW, TOGGLE, BATT CHG SELECTOR
S18	MS35059-22	SW, TOGGLE, ELECT HTRS
S17	B64-1225	SW, PRESS, FUEL OIL
S16	MS35058-22	SW, TOGGLE, LOAD CONTACTOR
S14	64B41365	SW, THERMAL, COOLANT
S13	MS35059-23	SW, TOGGLE, FUEL BRN. HTRS
S12	B52-1157	SW, ROTARY, LOCAL-REMOTE OPER
S10	MS35058-22	SW, TOGGLE, PANEL LIGHTS
S9	A52-1139	SW, PB, FAULT RESET
S8	B52-1129	SW, PRESS, LUBE OIL
S7	A52-411-3(1/2)	SW, CENT, OVERSPEED
S6	B52-1123	SW, THERMAL, COOLANT
S5	MS35059-23	SW, TOGGLE, FAULT BYPASS
S2	B52-1129	SW, PRESS, LUBE OIL
S1	A52-411-3(1/2)	SW, CENT, STARTER CUTOUT
R18	RV4NAYSD252A	RES, VAR, FREQ ADJ. 2500Ω 2W
R17	63M5-200K	RES, VAR, ISEC ADJ. 200K 1/4W
R16	RC20GF333J	RES, FIXED, COUPLING 33K 1/2W
R15	5XM5000	RES, FIXED, BURDEN 500Ω 5W
R14	B52-1089-1	RES, ADJ, VOLT DROP 6Ω 50W
R13	RP10FD751MK	RES, VAR-AUTO VOLT ADJ. 750Ω
R9	RC20GF274J	RES, FIXED, TIMING 270K 1/2W
R8	64B41266-1	RES, FIXED, CURRENT LIMIT
R7	64B41267	RES, ADJ, DAMPING
R6	RW29V431	RES, FIXED, VOLT DROP 430Ω 11W
R4,5	A52-1141	RES, FIXED, VOLT DROP 4500Ω 25W
R3	B52-1089-2	RES, ADJ, BATT CHG HIGH RATE 10Ω 50W
R2	B52-1088	RES, ADJ, BATT CHG LOW RATE 50Ω 25W
R1	63M5-1MEG	RES, VAR, 10SEC ADJ. 1MEG 1/4W
P4	MS3106R-14S-6S	PLUG, ELECT GOV ACTUATOR
P3	MS3106R-20-29S	PLUG, ELECT GOV COMPUTER
P2	MS3108E-32-7S	PLUG, CONTROL BOX
P1	MS3108E-36-7S	PLUG, CONTROL BOX
M9	6489062	IND, COOLANT TEMP.
M8	B52-1060	METER, FREQUENCY
M7	B52-1033	METER, PERCENT RATED CURRENT 0-133%
M6	B52-1027	METER, A.C. VOLTS 0-600
M5	2609935	METER, PERCENT RATED K.W. 0-140%
M4	B52-1062	AMMETER, D.C. 5-0-5
M3	B52-1059	IND, FUEL LEVEL E-F
M2	C52-1063	IND, LUBE OIL PRESS 0-80
M1	B52-1087	METER, ELAPSED TIME 0-99999 HRS.
L3	LBX8210A15-V	SOL, VALVE, ENG FUEL
L2	B52-1218	SOL, VALVE, FUEL BRN. HTR
L1	———	SOL, VALVE, ENG FUEL
K31	67C41471	RELAY, FUEL LEVEL CONTROL
K30	C-65-616	RELAY, STARTER ABUTMENT
K29	64B41405	RELAY, FIELD FLASH
K28	B52-1044	CONTACTOR, STARTER MTR PILOT
K27	B52-1066	RELAY, SHORT CKT. PH3
K26	B52-1066	RELAY, SHORT CKT. PH2
K24	B07A613BC1-0034	RELAY, BATT CHG SOURCE CHANGOVER
K23	69C38177	RELAY, TIME DELAY, 1SEC

Figure 3-2. Schematic Diagram (Sheet 3 of 3)

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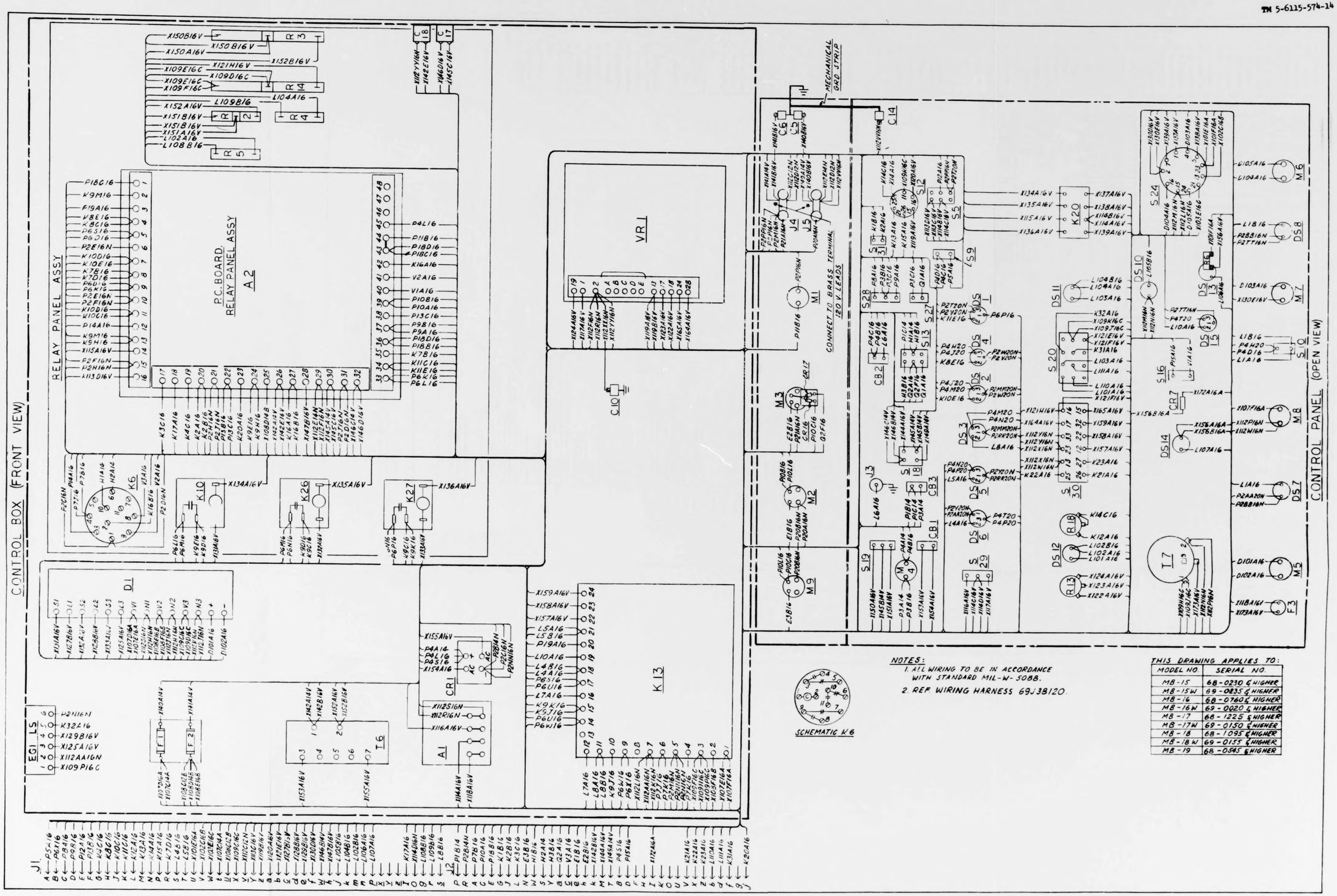

NOTES:
1. ALL WIRING TO BE IN ACCORDANCE WITH STANDARD MIL-W-5088.
2. REF. WIRING HARNESS 69J38120.

SCHEMATIC K6

THIS DRAWING APPLIES TO:

MODEL NO.	SERIAL NO.
MB-15	68-0230 & HIGHER
MB-15W	69-0835 & HIGHER
MB-16	68-0760 & HIGHER
MB-16W	69-0020 & HIGHER
MB-17	68-1225 & HIGHER
MB-17W	69-0150 & HIGHER
MB-18	68-1095 & HIGHER
MB-18W	69-0155 & HIGHER
MB-19	68-0545 & HIGHER

Figure 3-3. Control Box Wiring Diagram

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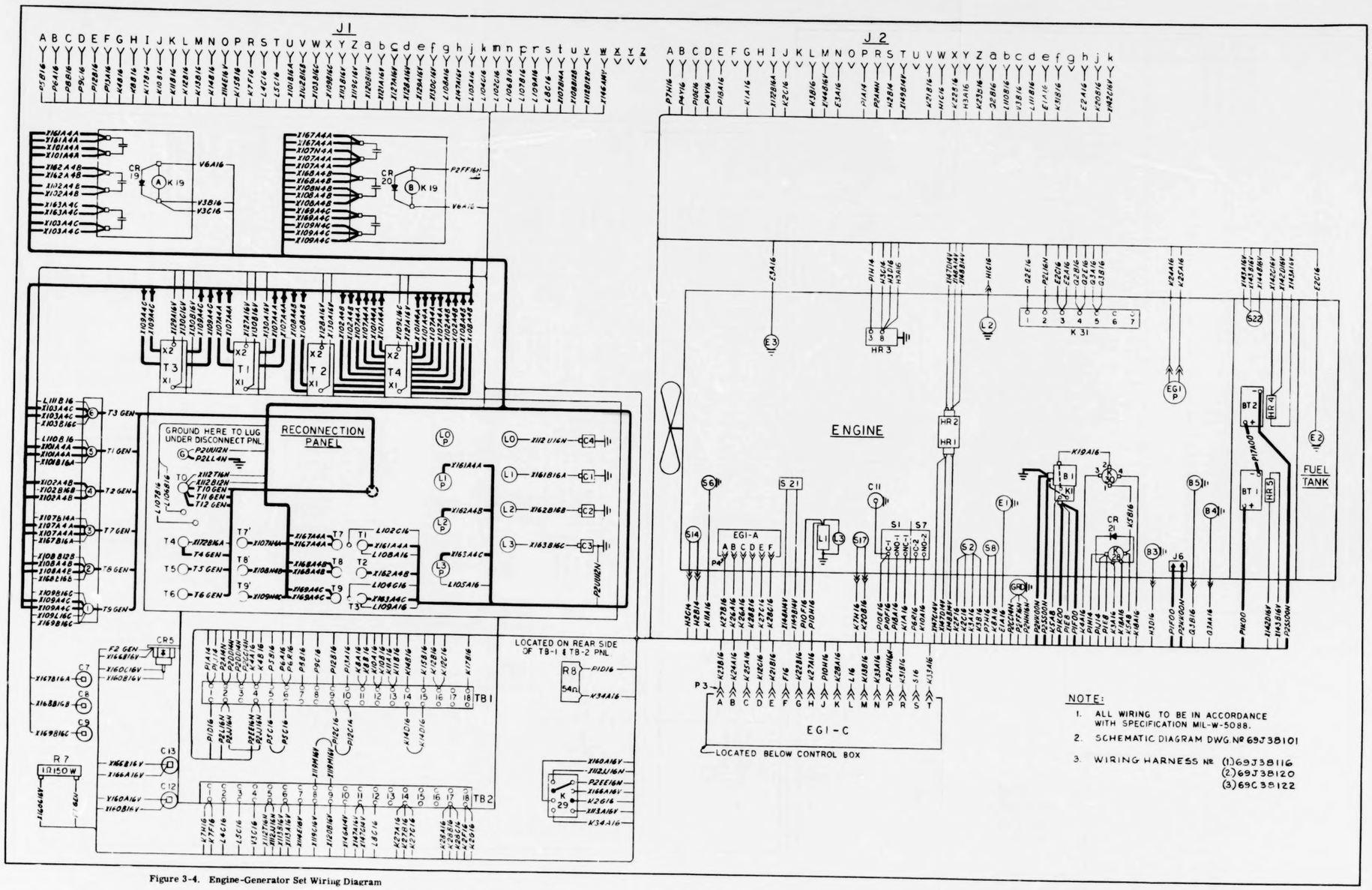

Figure 3-4. Engine-Generator Set Wiring Diagram

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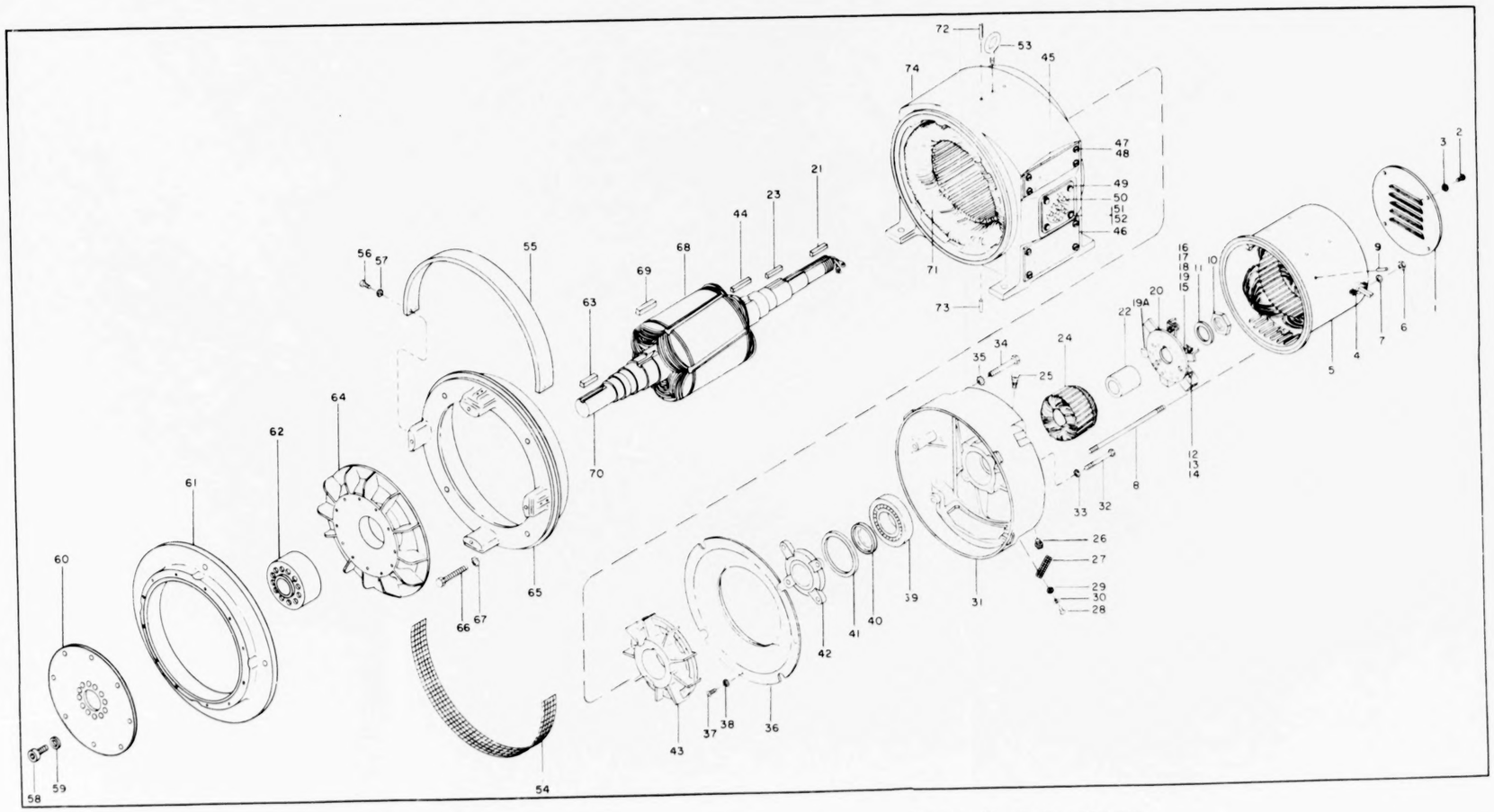

Figure 4-1. Alternating Current Generator

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